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MARTIN MARIETTA

Low-Level Radioactive Waste from Commercial Nuclear Reactors

Volume 3. Bibliographic Abstracts of Significant Source Documents

Part 1.

Open-Literature Abstracts for Low-Level Radioactive Waste

M. K. Bowers
B. R. Rodgers
R. L. Jolley

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ORNL/TM-9846/V3&P1

Chemical Technology Division

LOW-LEVEL RADIOACTIVE WASTE FROM COMMERCIAL NUCLEAR REACTORS*

VOLUME 3. BIBLIOGRAPHIC ABSTRACTS OF SIGNIFICANT SOURCE DOCUMENTS

Part 1.

Open-Literature Abstracts for Low-Level Radioactive Waste

(Activity KD 01 00 00 0, 00001)

M. K. Bowers**
R. R. Rodgers
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PREFACE AND ACKNOWLEDGMENTS

Volume 3 of this low-level radioactive waste (LLRW) treatment assessment series represents a collated collection of abstracts from most of the papers and reference documents used in this study of LLRW treatment methodologies. The volume is published as two separate documents. Part 1 contains general literature abstracts concerning most aspects of low-level waste treatment, packaging, storage, transportation, and disposal. To facilitate reference use, a limited keyword index is included in Part 1. Part 2 was prepared by personnel from Sargent & Lundy Engineers and deals more specifically with regulatory constraints affecting treatment, storage, transportation, and disposal. Each section of Part 2 includes a serial listing of document abstracts to expedite the location of a particular abstract.

Credit should be given to the editors who have critically examined and prepared the final version of these bibliographies: L. H. Bell, F. M. Scheitlin, and M. G. Stewart. Draft and final versions of the bibliographies could not have been accomplished without the diligent secretarial assistance of M. M. Dawson, D. S. Brown, and J. T. Shannon. We wish also to express our appreciation to R. G. Rader and G. Y. Jordy, U.S. Department of Energy, and J. P. Nichols, Oak Ridge National Laboratory, for supporting this endeavor.

ABSTRACT

The overall task of this program was to provide an assessment of currently available technology for treating commercial low-level radioactive waste (LLRW), to initiate development of a methodology for choosing one technology for a given application, and to identify research needed to improve current treatment techniques and decision methodology. The resulting report is issued in four volumes. Volume 3 of this series is a collection of abstracts of most of the reference documents used for this study. Because of the large volume of literature, the abstracts have been printed in two separate parts.

Volume 3, part 1 presents abstracts of the open literature relating to LLRW treatment methodologies. Some of these references pertain to treatment processes for hazardous wastes that may also be applicable to LLRW management. All abstracts have been limited to 21 lines (for brevity), but each abstract contains sufficient information to enable the reader to determine the potential usefulness of the source document and to locate each article. The abstracts are arranged alphabetically by author or organization, and indexed by keyword.

VOLUME 3. BIBLIOGRAPHIC ABSTRACTS OF SIGNIFICANT SOURCE DOCUMENTS

PART 1. Open-Literature Abstracts for Low-Level Radioactive Waste

INTRODUCTION

A thorough literature search is an important part of this comprehensive assessment of low-level radioactive waste (LLRW) management. The literature was found to contain a wealth of information that was often overlooked in considerations concerning treatment, storage, disposal, and transportation (TSDT) processes. The primary reason for this neglect has been the lack of a single document summarizing these references.

The reference listing compiled by the assessment staff during the course of this work became so large and unwieldy that the need for a bibliography of LLRW-related literature became obvious. Staff members concluded that others in the field could also benefit from an up-to-date listing, in abstract form, of this information that could be useful to them in making important decisions about TSDT processes in LLRW management.

Because of the large volume of literature in this field, these abstracts have been published in two separate documents: Volume 3, Part 1: Open-Literature Abstracts for Low-Level Radioactive Wastes, and Volume 3, Part 2: Bibliography for Treatment, Storage, Disposal, and Transportation Regulatory Constraints. Part 1 presents abstracts of the open literature relating to LLRW treatment methodologies. Some of these references pertain to treatment processes for hazardous wastes that may also be applicable to LLRW management. Part 2 presents abstracts of the voluminous regulatory constraint documents that relate to all phases of LLRW management. This latter bibliography was prepared by personnel of Sargent and Lundy Engineers, under subcontract to ORNL. Only minor editorial changes were incorporated.

When the open-literature abstract provided for the article was sufficient, it was used intact in this Part 1 bibliography. In most cases, the abstracts were augmented by the assessment staff. All abstracts have been limited to 21 lines (for brevity), but each abstract should contain enough information to enable the reader to determine the potential usefulness of the source document. Information enabling the reader to locate

each article is also presented. To make the bibliography even more useful, the abstracts are arranged alphabetically by author or organization, and indexed by keyword.

The final consideration, when a compilation of this kind is completed, is how to determine its usefulness. If those bibliographies provide a significant service, perhaps means can be found to update them annually. Readers are encouraged to send comments concerning the usefulness of the bibliographies in Part 1 and Part 2 of Volume 3 to B. R. Rodgers or R. L. Jolley, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee 37831.

Acox, T. A.

AN INVESTIGATION OF FLUIDIZED-BED BIOLOGICAL DENITRIFICATION
GAT-S-32, Goodyear Atomic Corporation/DOE, December 1982.

The introduction of fluidized-bed technology into the field of wastewater treatment, and specifically biological denitrification, is a comparatively recent development. In fluidized-bed biological denitrification, wastewater passes upward through a bed of fine support particles, such as sand or granular coal, at sufficient velocity to cause motion or fluidization of the media. This mode of operation avoids the clogging problems encountered under packed-bed operation while providing a surface area more than an order of magnitude greater than the packed bed; this allows for extremely high biomass concentrations in the reactor. These high biomass concentrations allow substrate conversion efficiencies much greater than those possible in conventional biological reactors.

Aerojet Energy Conversion Company

VOLUME REDUCTION SYSTEM - COMPLETE LOW-LEVEL RADIOACTIVE WASTE PROCESSING
AECCWMS-VR-1282/1000, Promotional Brochure, Aerojet Energy Conversion Company, circa 1984.

Low-level radioactive wastes generated at nuclear power plants present an ever-increasing disposal problem for the nuclear utility industry. The primary problems of disposal practices at nuclear power plants are: utility waste allocation reductions at commercial burial sites; high-priced service contracts for mobile solidification systems; and escalating burial, inspection, and transportation rates.

Utilities are increasing their capital expenditures to procure systems that guarantee efficient, state-of-the-art processing of radioactive wastes. Maximum volume reduction provided by a reliable system is the requirement — Aerojet's Volume Reduction System is an example. The fluidized-bed incinerator is the process used, and by using two process vessels, liquid and combustible wastes can be processed simultaneously. The end product from the Aerojet Volume Reduction System can be immobilized in polymer, cement, and bitumen solidification systems supplied by several companies. Nine Aerojet systems have been sold in the United States.

Air Force Engineering & Services Laboratory

FY 85 R&D PROJECT DESCRIPTIONS - ESL ENVIRONICS DIVISION
Air Force Engineering & Services Center, Tyndall AFB, Florida, July 1984.

This article includes the R&D project descriptions as follows: (1) hazardous wastes - 31 listings, and (2) Air Force fuels and chemicals - 31 listings.

Alexandre, D.

NEW ALTERNATIVES FOR PROCESSING LOW- AND MEDIUM-LEVEL LIQUID WASTES
Fuel Reprocessing/French CEA, March 1984, pp. 2-163 to 2-176.

After a brief presentation of the actual scheme for low-level and intermediate-level radioactive liquid waste treatment in the new reprocessing plant of "La Hague," the new trends in research and development studies are presented.

In a first step, the total amount of low level and intermediate-level wastes could be concentrated by distillation, with disposal of condensates. Concentrates, prior to conditioning, could be treated by chemical precipitation or by mineral ion exchangers. The saline solution, then free of major radionuclides could be immobilized in bitumen and sent for disposal in surface storage conditions. The solid residual fraction, sludges or saturated ion exchangers, could be converted to oxides and sintered for deep geological disposal.

Allen, C. R.

RADIOACTIVE ACID DIGESTION TEST UNIT (RADTU) - 1980
HEDL-SA 2239, Hanford Engineering Development Laboratory, 1980.

The Radioactive Acid Digestion Test Unit (RADTU) was constructed at the Hanford Site, Richland, WA, to demonstrate application of the acid digestion process for treating combustible transuranic wastes and scrap materials. Using its original tray digester vessel, RADTU recently completed a six-month campaign of processing potentially contaminated non-glove-box wastes from a Hanford plutonium facility. During the campaign, 2100 kg of largely cellulosic wastes was processed at an average sustained processing rate of 3 kg/h (limited by the acid-waste contact and the water boiloff rate from the acid feeds). On-line operating efficiency was nearly 50%, averaged over 12 h/d, for 5 d/week. After shutdown, a new annular high-rate digester was installed for testing that demonstrated a sustained capacity of 8 to 10 kg/h with greatly improved contact between the digestion acid and the waste. The new unit began processing low-level waste from Hanford's Z-Plant during June 1980. Plutonium levels in the processed waste will be increased gradually as operating experience is gained. Processing recoverable scrap is expected to begin in the last quarter of CY 1980.

American Nuclear Society

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 43, pp. 127-33, November 1982.

"Waste Volume Reduction Through Treatment and Minimizing Generation" includes the following articles:

1. Decontamination of Uranium-Contaminated Solid Waste to Releasable Levels
2. Advances in Decontamination Technology
3. Radwaste Volume Reduction and Solidification by General Electric
4. Evaluation of an Asphalt System for an Operating BWR
5. Radwaste Volume Reduction Using Mobile Processing Equipment
6. Technologies for Destroying Low-Level Radioactive Waste Nitrate
7. A Survey of Contaminated Oil Treatment Alternatives
8. Identification of Radwaste Sources and Reduction Techniques, EPRI Project RP1557-3

American Nuclear Society

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 45, October-November 1983.

"Low-Level Waste Management I" includes the following articles:

1. Liquid Radwaste: An In-Depth Analysis of Source, Storage Treatment, Transportation, and Disposal
2. Evaluation of a Processing Technique for Immobilization of Low-Level Waste
3. Resin Waste Management for Nuclear Reactors
4. Wet Oxidation of Spent Ion-Exchange Resins and Filter Sludges
5. Decomposition of a Radioactive Ion-Exchange Resin by a Pyrolysis Technique
6. TRU Waste Impact

American Nuclear Society

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 45, October-November 1983.

"Low-Level Waste Management II" includes the following articles:

1. Steam Generator Decontamination Waste: Factors Affecting Process System Selection
2. A New Waste Form for Ion-Exchangers
3. Removal of Radioactive Cobalt from Highly Saline Streams
4. Diffusion-Bonded HGMS Filter for BWR Cooling Water
5. Sludge Removal in Radwaste Collection Tank
6. Low-Level Power Plant Cement Solidified Waste Leaching Study
7. Geochemistry of Trench Leachates from Maxey Flats Disposal Site

American Nuclear Society

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 45, October-November 1983.

"Low-Level Waste Processing and Economics" includes the following articles:

1. Economics of Low-Level Radioactive Waste Disposal Facilities
2. Economic Incentives to Combine On-Site Storage with a Radwaste Volume Reduction System Retrofit
3. Concentration of Radioactive Waste Using a Solar Collector System
4. Capital and Operating Costs of LWR Low-Level Radwaste Volume Reduction Installations for Disposal Planning
5. Sensitivity of Low-Level Waste Disposal Costs to Volume Reduction Scenarios
6. The Impact of Disposal Regulations on Volume Reduction Economics

American Nuclear Society

PROCEEDINGS - FUEL REPROCESSING AND WASTE MANAGEMENT - INTERNATIONAL TOPICAL MEETING
Vol. 1, American Nuclear Society, August 1984.

The following papers were presented:

1. Plenary: Overview of Reprocessing and Waste Management
2. Activities — 7 papers
3. High-Level Waste I — 7 papers
4. Chemistry I — 7 papers
5. Spent Fuel Management Options — 5 papers
6. High-Level Waste II — 7 papers
7. Chemistry II — 7 papers
8. Low-Level, Intermediate-Level, and TRU Waste I — 5 papers

American Nuclear Society

PROCEEDINGS - FUEL REPROCESSING AND WASTE MANAGEMENT - INTERNATIONAL TOPICAL MEETING
Vol. 2, August 1984.

The following papers were presented:

1. Equipment Design I — 7 papers
2. Fuel Storage — 7 papers
3. Low-Level, Intermediate-Level, and TRU Waste II — 5 papers
4. Breeder Fuel Reprocessing I — 6 papers
5. Off-Gas Technology — 7 papers
6. Equipment Design II — 7 papers
7. Breeder Fuel Reprocessing II — 6 papers
8. Meeting Attendees

Andreacola, E.; Irrgang, G.

GENERATORS: CHOOSE INCINERATION SYSTEMS WITH CARE
Hazardous Materials and Waste Management, pp. 27-28,
September-October 1984.

To best ensure the installation of a successful system, waste generators should equip themselves with a knowledge of their wastes, their options, and their suppliers. In preparing to determine the needs for an incineration system, two elements should be considered before any others: waste composition and flow. In addition, it is prudent to anticipate and consider future changes in the waste generated. Most basically, hazardous wastes can be divided into three groups: (1) pure organics; (2) acid-producing wastes; (3) and ash-producing wastes.

If a decision is made to incinerate on-site, waste generators must become acquainted with the types of systems available. Common choices include: (1) liquid injection incinerators, (2) rotary kilns, (3) fluidized-bed incinerators, and (4) multiple-hearth incinerators.

Certain criteria should be considered in selecting the most effective supplier. It is important to ensure that those selected possess adequate experience in water incineration and in the incineration of a generator's particular wastes.

Armstrong, K. M. and Klingler, L. M.

GLASS FURNACE PROJECT; OCTOBER 1982-MARCH 1983
MLM-3067, Monsanto Research Corporation/DOE, May 1983.

In the Glass Furnace Project currently under way at Mound Laboratory, a treatment technology for a low-level radioactive waste is being evaluated that will combine volume reduction and immobilization in one step. Initial work focused on demonstrating the ability of the furnace to efficiently incinerate nonradioactive, simulated power-plant waste and on determining the adequacy of immobilization in a soda-lime silica matrix. Further evaluation of the system will involve a demonstration of the combustion and containment of radioactive waste. In preparation for this next phase of the program, preliminary investigation and design work were conducted during the past six months.

Arner, L. D.; Johnson, G.; Masters, H; Skoronek, H. S.

TOXIC AREA DELINEATION BY CANINE OLFACTION
EPA, 1984.

The purpose of this preliminary or feasibility study was to demonstrate that:

1. a dog could track chemicals that humans had defined as toxic and/or hazardous;
2. the dog could locate very small quantities of these chemicals in environmental situations that approximated old disposal sites or small leaks from buried tanks and drums;
3. a dog could be trained to assist in defining an area contaminated with toxic or hazardous chemicals or to indicate contaminated equipment at such a site; and
4. that such work could be carried out with minimal risk to both dog and handler while offering a safety benefit to those working in the area or living nearby.

In view of the experience during the project, additional work is warranted on the use of canine detection, both to improve confidence in the capabilities of the technique and to identify and explore specific applications where the dog's olfactory ability may offer unique operational advantages.

Ashwood, T. L.

COMPILATION OF DOE HAZARDOUS WASTE HANDLING TECHNOLOGIES - FINAL DRAFT
Oak Ridge National Laboratory/HWP/DOE, September 1983.

This report was prepared from responses to a request for information on existing hazardous waste handling technologies. In some cases, the responses were supplemented by reviews of published reports. However, no attempt has been made to verify reported information.

The purpose of this report is simply to provide a starting point for information exchange among DOE facilities on the subject of hazardous waste technologies. Radwastes were included because of potential transfer of technology to hazardous wastes. As additional information becomes available, the report will be updated.

Each of the data sheets in this report provides a brief summary of the technology used, the category of wastes involved, and a reference for further information. The data sheets are organzied by technology type.

Ashwood, T. L.; Fore, C. S.; Craig, R. B.; Burton, D. W.; Walls, D. M.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - FY 1984 SITE VISIT SUMMARY REPORT
DOE/HWP-3, Oak Ridge National Laboratory/HWP/DOE, February 1985.

Site visits were being made to each of the DOE defense installations to understand their missions, organizations, and operations and to identify the technologies being used and to pinpoint those that are still needed for efficient hazardous waste management.

The primary objective of the site visits was to establish a rapport between the sites and the HWP staff. A secondary objective was to gain specific information on each site's hazardous waste managment practices and problems.

Seventeen sites were visited, and each site visit was documented in a Site Visit Report (SVR), with distribution limited to the SCO, ORO, and the Field Office responsible for the site. The purpose of this summary report is to present the general results to a broader audience.

Associated Technologies Inc.

ATI INCINERATOR AT REGIONAL RADWASTE FACILITY IN NORTH CAROLINA WILL REDUCE OVER 2400 TONS OF DRY ACTIVE WASTE BY A FACTOR OF 20 TO 40
News Release #ATI 082284, Associated Technologies Inc., 1984

A regional, low-level radwaste incinerator facility designed to service the states in the Southeastern Compact, was recently announced by U.S. Ecology, Inc. A contract for the design and construction of the facility, including the design and supply of the incineration system, has been awarded to Associated Technologies Inc. (ATI) of Charlotte, North Carolina. The incinerator will be capable of reducing over 2400 tons of DAW by a factor of 20 to 40. Four types of waste can be incinerated, either separately or in any combination. They are Dry Active Waste (DAW), pathological waste, scintillation fluids, and turbine oil. The ATI incinerator volume reduction factor for precompacted DAW will typically be from 20 to 24:1, depending upon the waste form. For scintillation fluids and turbine oil, the volume reduction factor will be 99:1. The incinerator ash will be packaged in 55-gallon drums for shipment to a burial site. One of the two sites presently being considered for the regional incinerator is in northwestern Bladen County, which is the site named by U.S. Ecology in their initial application, and the other is in Wayne County, for which an option is being sought.

Associated Technologies Inc. TECHNOTES

INCINERATION OF RADWSTE TO ACHIEVE VOLUME REDUCTION
Vol. 1, No. 2 - Promotional Brochure, Associated Technologies Inc., 1984.

The greatest volume reduction of many kinds of radioactive waste is achieved through incineration. However, incinerating radioactive waste has not yet become an industry practice. The reasons are many and varied. The purpose of the TECH NOTES is to report on two success stories.

One of them is an institutional size incinerator located at the University of Maryland at Baltimore (UMB), and the other is the first of its kind, the recently announced large, regional facility that will be located in North Carolina and operated commercially by U.S. Ecology (USE). Both the UMB and USE incinerator systems are the design of Associated Technologies Inc. (ATI) of Charlotte, NC, and both use the controlled-air incineration concept.

Ault, G. M.; Reiss, J. F.

MODIFICATION OF AN EXISTING RADWASTE FACILITY TO PROVIDE ONSITE LOW-LEVEL WASTE STORAGE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 423-6, March 1985.

The decision of whether or not to install onsite storage capacity for low-level radioactive waste is dictated by individual utility circumstances. Commonwealth Edison has decided to construct facilities to store low-level radwaste onsite at each of their four operating nuclear stations, and they plan to have those facilities in operation by January 1986. At Dresden, that onsite storage capacity is being provided by modifying an existing radwaste building which already has installed a remotely-operated precision-placement type crane. The purposes of this paper are to describe: (1) how Commonwealth Edison arrived at the decision to construct onsite storage facilities as a hedge against possible disruption of burial site availability in January, 1986, (2) why the desire to minimize the capital investment for this protection led to selection of an uncomplicated design for their "standard" facility and to the decision to modify an existing building at Dresden rather than contruct a new one, and (3) what is being done to adapt the Dresden 1 Decontamination/Radwaste Building for extended onsite storage.

Babcock & Wilcox

WASTE MANAGEMENT CONSULTING
Promotional Brochure PB-256-1M, Babcock & Wilcox, March 1985.

Babcock & Wilcox's Waste Management Consulting Service offers comprehensive programs which can help reduce the quantity of radioactive waste generated in a plant, limit the amount of material that must be buried, and reduce costs to operate waste processing facilities and systems, including liquid waste evaporators and ion exchange systems.

Examples of the types of solutions provided include:

1. volume reduction through methods such as incineration and compaction;
2. radwaste systems,
3. evaporators, and
4. ion exchange optimization.

Baillod, C. R.; Lamparter, R. A.; and Barna, B. A.

WET OXIDATION FOR INDUSTRIAL WASTE TREATMENT
Chemical Engineering Progress, Vol. 81, No. 3, pp. 52-56, March 1985.

A design and economic evaluation of the wet-oxidation process has been applied to the treatment of a problem wastewater stream produced in an existing petrochemical facility. The waste posed a problem because it inhibited the biological treatment facility at the plant site. Thus, it was being barrelled and hauled at considerable expense. Wet oxidation is an attractive alternative because the biological inhibition is reduced and energy recovery from the relatively high-COD waste is feasible. The plant can utilize the energy recovered either in the form of 450-kPa (50-psig) process steam or as boiler feed water preheat.

For those wastes that are not biotreatable, wet oxidation is an economically attractive method of treatment in reducing oxygen demand and altering the biotreatability. Further, when biological treatment changes are based on COD, the cost of wet oxidation is not much greater than typical municipal industrial charges.

Baker, R.; Feizollahi, F.

IN-PLANT LOW-LEVEL RADWASTE TECHNOLOGY NEEDS
EPRI NP-3117, NUS Corporation/EPRI, May 1983.

An industry-wide survey of current low-level radwaste technology was conducted to formulate a unified low-level radwaste technology improvement program. The survey reviews present designs and applications of various materials, components, and systems at both PWRs and BWRs. The performance of each subsystem of a plant radwaste management system is reviewed, and present problems relating to process design and plant operation and maintenance are discussed. The needs generated by these problems are identified and reviewed in order to develop a comprehensive R&D program dedicated to improving radwaste management technology. A program made up of three subprograms is proposed. The three parts are: (1) existing waste generation and treatment systems, (2) alternative technologies, and (3) alternative operation and maintenance practice.

Alternatives for the objectives, management, monitoring, implementation, sponsorsip, scheduling, budget, and goals of each subprogram are described in this report.

Barcalow, J. C.; Miller, C. C.

MOBILE SOLIDIFICATION SYSTEM INTERFACE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 427-31, March 1985.

This paper discusses design considerations for mobile solidification system interfaces at the Clinton Power Station. A description of the mobile interface design is presented. The details regarding the pipe routing, valve selection, and flushing provisions are included. The mobile solidification station, which centralizes all the interface requirements, is described. The control logic and new control panel are also discussed.

Barclay, K. M.; Yosim, S. J.; Gay, R. L.; and Grantham, L. F.

DISPOSAL OF PERCHLOROETHLYENE BOTTOMS BY MOLTEN SALT COMBUSTION
AI-77-82, Rockwell International/Oak Ridge National Laboratory, November 1977.

In the Molten Salt Combustion Process, waste and air are continuously introduced beneath the surface of a sodium carbonate-containing melt at 850 to 950°C. The intimate contact of the hot melt, air, and waste provides for complete and immediate destruction of the combustible material. Acidic gases such as HCl (produced from chlorinated organic compounds) are instantly neutralized and absorbed by the alkaline Na_2CO_3. After removal of particulates in a cyclone and a baghouse, the clean off-gases produced, CO_2 and H_2O (in addition to N_2 and O_2), are released to the atmosphere. The temperatures of combustion are too low to permit any significant amounts of nitrogen oxides to form by fixation of the nitrogren in the air. The noncombustible ash and inorganic combustion products (e.g., NaCl) are retained in the melt which is discharged from the furnace and dissolved in water. Ash is removed by filtration and the filtrate is processed to separate Na_2CO_3, which is returned to the combustor. The test program consisted of three general areas: (1) combustion of the perchloroethylene bottoms, (2) recovery of the uranium from spent melt, and (3) preparation of a preliminary conceptual design of a system.

Barthoux, A.

RECENT DEVELOPMENTS IN THE FIELD OF LOW- AND INTERMEDIATE-LEVEL WASTE DISPOSAL IN FRANCE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 37-40, March 1985.

The French Government announced in mid-1984 the decision to start a program for creating two new shallow-land repositories and published a new "Fundamental Safety Rule" giving the framework of the safety requirements for ANDRA (Agence Nationale pour la gestion des Dechets radioactifs). A series of new actions has been started in the field of quality assurance to guarantee the safety of the whole management system, including the operations carried out by the producers for treating and conditioning the waste. A comprehensive system has also been set up to calculate the detailed activity present in the repository and to define the location of the packages. Several suitable zones have been nominated to start the site investigations. Two sites must be proposed to the government before the end of 1985. A series of studies has started to improve the design of the repository in the light of the experience gained at the Centre de la MANCHE.

Bates, L. D.; Van Hoesen, S. D.

DEVELOPMENT OF THE CENTRAL WASTE DISPOSAL FACILITY
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 147-53, March 1985.

The Central Waste Disposal Facility is a proposed facility for shallow-land burial of low-level radioactive waste on the Department of Energy's Oak Ridge Reservation near Oak Ridge, Tennessee. The facility development has proceeded through site characterization, facility design, assessment of environmental impacts via pathways analysis, and preparation of an environmental impact statement. The worst-case pathways analysis indicated that expected performance of the facility was within the performance goal of 25 mrem/yr maximum off-site exposure as defined in the Code of Federal Regulations (10 CFR Part 61). Similar exposure calculations were also completed for an alternative aboveground disposal option. Due to comments regarding the applicability of the stated performance standard as well as related questions on the facility design, philosophy, and siting, further development of the facility has been delayed pending resolution of these issues.

Baudisch, H., et al.

DAW VOLUME REDUCTION (VR) USING THE NEWLY DEVELOPED 20-MN (22,000-TON) SUPERPACK - A NEW GENERATION OF SUPERCOMPACTOR EQUIPMENT
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 513-15, March 1985.

During a backfitting campaign from September 1982 to September 1983, the Brunsbuttel Nuclear Plant located in West Germany, produced approximately 100 tons of pressable waste, which was all precompacted in more than 4000 caustic soda drums of 180 L each (47.5 U.S. gallons). Some 2365 of these drums have been transformed into 658 drums of 55-gal content using: the 20-MN SUPERPACK (TM) of Hansa-Projekt (HP), serviced by INET Corporation in the United States. SUPERPACK is a space- and cost-saving solution for waste management, fulfilling all safety requirements.

The SUPERPACK used in Brunsbuttel gave a volume reduction factor (VRF) of 3.6 for drums which were precompacted by a factor of about four. These results are based on an experience of more than 4000 pressed drums. This is a very cost-effective low-level waste management technique; the equipment cost was amortized in less than one year. Availability of the system was better than 95% during its first year of operation.

Beatty, R. N.; Livingston, R. A.

RADWASTE PROCESSING AT THE ADVANCED TEST REACTOR FACILITY
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 441-4, March 1985.

The Advanced Test Reactor (ATR) is a 250-MW (thermal) water-cooled reactor located at the Idaho National Engineering Laboratory. The reactor is used primarily to test materials in a radiation environment for defense-related programs. Operation of this facility includes processing of radioactive waste streams in solid, liquid, and gaseous forms. Since the materials tested in reactor experiment facilities are sometimes destructively tested, the radwaste process capabilities for experimental facilities must be capable of handling a relatively wide range of contamination levels in the waste streams. Modifications to the original plant (designed in 1967) have been concerned with reducing the volume and activity level of liquid waste. Included are modular filtration and ion-exchange units that were developed to convert canal cleanup from an open-loop flush to a closed-loop recirculation system. Another plant improvement involved an ion-exchange treatment system that reduces the level of radiological contamination in the low-level waste water. A system to evaporate the water from high-level waste presently in development is also discussed.

BeCraft, F. B.; Jenkins, W.

OZONE USAGE IN THE TREATMENT OF WATER AND WASTEWATER - A LITERATURE SURVEY
GAT-T-2530, Goodyear Atomic Corporation, May 1976.

Since the time when the disinfectant properties of ozone were first discovered, it has been used for decomposing undesirable organic compounds by chemical oxidation in both small- and large-scale operations. Although foreign municipalities and industries have used ozone to treat water and wastewater in recent years, the availability of inexpensive chlorine and the lack of need for vigorous treatment have limited its use in this country to certain industries which exploit its great oxidizing ability. Recently, there has been a growing interest in the United States in using ozone because of its greater ability than chlorine to destroy bacteria and viruses and to avoid the harmful secondary pollutants sometimes produced by chlorine treatment. Although ozone appears to be a more effective disinfecting agent than chlorine with a wider range of applicability, it has been generally a more expensive treatment. In certain cases, reduced power rates or savings in chemical costs could outweigh this disadvantage, but ozone will probably remain a slightly more expensive treatment and will replace the use of chlorine only in situations where it is necessary to improve unacceptable water quality standards when chlorine is used.

Bemden, E. V. (Technical Program Chairman)

Transactions of the American Nuclear Society, Vol. 40, April 1982.

"Waste Management Strategy" includes the following articles:

1. A Production Facility for the Solidification of Radioactive Liquid Wastes

Ben-Hur, D.; Smith, J. S.; Urban, M. J.

APPLICATION OF MOBILE MS/MS TO HAZARDOUS WASTE SITE INVESTIGATION
Weston Designers-Consultants/EPA , November 1984.

In recent years, application of MS/MS technology has been advanced significantly in the areas of air monitoring and dioxin analysis. In both applications the technique offers advantages that are unparalleled by conventional modes. Specifically the technique offers real-time analysis; detection, identification, and quantitation at very-low levels; and high specificity. Results of both types of applications are discussed in this paper. This discussion, however, is preceded by some details of the instrumentation.

Bennett, J. W.

REPOSITORY PLANS/ANTICIPATED PROGRESS AND PROBLEMS WITH SITING
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 19-24, March 1985.

The geologic repository program within the Office of Civilian Radioactive Waste Management has made considerable progress during 1984 in implementing the site-selection process mandated in the Nuclear Waste Policy Act of 1982. The progress made in 1984 demonstrates that the Department is well along in the first of five major program phases, leading to licensing of the Department to receive spent fuel in 1998 for emplacement in the geologic repository. The phases include: (1) recommendation of sites for characterization, (2) characterization of sites, (3) selection and approval of one site for development as a geologic repository, (4) construction authorization for that site, and (5) construction and performance confirmation testing for the geologic repository. The Department remains firmly committed to, and has entered into disposal contracts based on, receipt of spent fuel in 1998 for emplacement in a gelologic repository for permanent isolation from the biosphere. In this paper, the author describes the status and management strategy associated with each program phase, discusses major milestones associated with each program phase, and highlights those opportunities or obstacles which have the potential to accelerate or delay goals.

Bennett, R. D.; Miller, W. O.; Warriner, J. B.; et al.

ALTERNATIVE METHODS FOR DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES.
TASK 1: DESCRIPTION OF METHODS AND ASSESSMENT OF CRITERIA
NUREG/CR-3774, Vol. 1, February 1984.

The overall objective of this study is to ensure that the criteria needed to evaluate five alternative LLRW disposal methods are available to the NRC and the Agreement States. The alternative methods considered are: (1) belowground vaults, (2) aboveground vaults, (3) earth-mounded concrete bunkers, (4) mined cavities, and (5) augered holes. Each of these alternatives is either being used by other countries for LLRW disposal or is being considered by other countries or U.S. agencies or states. In this report the performance requirements are listed, each alternative is described, the experience gained with its use is discussed, and the performance capabilities of each method are addressed. Next, the existing 10 CFR Part 61 Subpart D criteria with respect to paragraphs 61.50 through 61.53, pertaining to site suitability, design, operations and closure, and monitoring are assessed for applicabiity to evaluation of each alternative. Preliminary conclusion and recommendations are offered on each method's suitability as an LLRW disposal alternative, the applicability of the criteria, and the need for supplemental or modified criteria.

Berkowitz, J. B., et al.

PHYSICAL, CHEMICAL, AND BIOLOGICAL TREATMENT TECHNIQUES FOR
INDUSTRIAL WASTES - VOL. I
PB-275 054, Arthur D. Little, Inc., November 1977.

There is a strong need for treatment processes that can detoxify, destroy, or apply resource recovery principles to industrial wastes. This study examined 47 unit engineering processes for their applicability to the task of treating hazardous industrial wastes. Some of these unit processes are commonly used for industrial waste treatment, while others require further R&D efforts before they will become commercially attractive. Four (dialysis, electrophoresis, freeze-drying, and zone refining) were found not to be applicable to waste treatment. Part Two of this report presents comprehensive descriptions of each of the unit processes, including information on the basic principles, areas of application, economics, energy and environmental considerations, and an outlook for future use on industrial wastes. Thus, Part Two, is in essence, an up-to-date reference textbook on potential treatment processes.

Best, W. T.; Turney, J. H.; Gardiner, D.

EVALUATION OF THE MISCELLANEOUS WASTE EVAPORATOR AT RANCHO SECO
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 555-60, March 1985.

In June 1984, Sacramento Municipal Utility District gave Impell Corporation the authority to proceed with an evaluation of the operation of the miscellaneous waste evaporator. The purpose of the evaluation was to optimize the operation of the evaporator, with the intent to simplify and reduce the cost of waste handling within the plant. This paper analyzes several suggested solutions to achieve the above.

Bird, M. V.; Thompson, J. D.

CONCEPTUAL DESIGN REPORT FOR REGIONAL LOW-LEVEL WASTE INTERIM STORAGE SITE
EGG-WM-5434, EG&G Idaho, Inc., August 1981.

In order to provide information on interim storage for low-level radioactive waste, the Low-Level Waste Management Program has undertaken the conceptual design of such a facility. Several assumptions were made to permit the calculation of the approximate cost and complexity of the required facility. Key assumptions are that 100,000 ft^3 (2800 m^3) of waste is received at the facility each year, that storage modules holding 100,000 ft^3 (2800 m^3) of waste would be used, that all waste would be solidified in 55-gal drums, and that all waste received would be 200 mrem/h or less at contact. Each area would have to assess its own situation. Few regions will be able to enforce 100% of generators to ship solidified waste in 55-gal drums. Also, a maximum of 200 mrem/h at contact is probably unattainable for some unshielded waste. Clearly, the site chosen and the actual volume of waste to be handled will have an influence on building design and the juxtaposition of facility components. All of these being the case, the above simplifying assumptions were made, and the present conceptual design is the result. The inspected waste will be kept in storage for five years or more and then placed in a disposal facility.

Blakeslee, J. J.

LOW-LEVEL WASTE TREATMENT R&D
RFP-3181, presented at the National LLRW Management Information Meeting, January 1981.

This discussion concerns a new task in the area of reduced waste generation funded by the LLRW Program. The objective of the task is to destroy nitrate wastes by converting the nitrate radical to a carbonate radical and nitrogen without creating appreciable quantities of nitrogen oxides. It has been hypothesized that large quantities of nitrate salts which result from wastewater evaporation processes may be reacted safely with carbon to form nitrogen gas and carbonate. Materials other than carbon, such as urea, may also be used to destroy nitrates, but carbon is by far the most attractive and beneficial. The major benefits to be derived from this technology are an estimated 20% volume reduction, while eliminating the fire hazard associated with large amounts of nitrate salt. Supplementary benefits might be that the carbonate generated could be recycled back into the waste stream to neutralize more acid waste. It has also been postulated that waste graphite, which exists in large abundance, might serve as a source of carbon. This procedure would result in a process which uses one waste product to destroy another. A fluidized-bed reaction is the technology to be exploited for this purpose.

Blasewitz, A. G.; Allen, C. R.; Lerch, R. E.; et al.

OPERATION OF THE RADIOACTIVE ACID-DIGESTION TEST UNIT (RADTU)
IAEA-SM-246/247, International Atomic Energy Agency, 1981.

The RADTU has been constructed at Hanford to demonstrate the application of the acid-digestion process for treating combustible transuranic wastes and scrap materials. The RADTU, with its original tray digestion vessel, has recently completed a six-month campaign of processing potentially contaminated non-glove-box wastes from a Hanford plutonium facility. During this campaign, it processed 2.1 Mg of largely cellulosic wastes at an average sustained processing rate of 3 kg/h, as limited by the acid-waste contact and the water boiloff rate from the acid feeds. The on-line operating efficiency was nearly 50% on a 12-h day, five-day week basis. Following this campaign, a new annular high-rate digester has been installed for testing. In preliminary tests with simulated wastes, the new digester demonstrated a sustained capacity of 10 kg/h with greatly improved intimacy of contact between the digestion acid and the waste. The new design also doubles the heat-transfer surface, which is expected to provide at least twice the water boiloff rate of the previous tray-digester design. The new unit will be used to process combustible plutonium scrap and waste from Hanford plutonium facilities.

Blasewitz, A. G.; David, J. M.; Smith, M. R. (Editors)

THE TREATMENT AND HANDLING OF RADIOACTIVE WASTES
The American Nuclear Society Topical Meeting, Battelle Press, 1983.

The following papers presented at the meeting were categorized as follows:

1. National Overviews — 7 papers
2. High Level Waste Management Practices — 7 papers
3. Decontamination and Size Reduction — 6 papers
4. Incineration Technology — 7 papers
5. High-Level Waste Vitrification Technology — 8 papers
6. LLRW and ILRW Management Practices — 8 papers
7. Transuranic Waste Management — 8 papers
8. Alternative High-Level Waste Forms — 6 papers
9. TRU Waste Management Practices — 6 papers
10. Aqueous Treatment Technology, Non-HLW — 6 papers
11. Panel Session: Remote Aspects of Treating and Handling Radioactive Wastes — 4 papers
12. Treatment of Defense High-Level Waste — 6 papers
13. Low-Level Waste Disposal — 7 papers
14. Immobilization Technology for Non-High-Level Waste — 7 papers
15. Treatment of West Valley High-Level Waste — 5 papers
16. Waste Handling — 6 papers Transportation and Disposal
17. Considerations — 7 papers Plenary Session: Summary and Trends — 3 papers

Bock, D.; Sullivan, P.

SELECTED METHODS FOR DETECTING AND TRACING HAZARDOUS MATERIALS SPILLS
EPA-600/2-79-064, Calspan Corporation, March 1979.

Detection of hazardous chemicals by a wide range of phenomena, including electrical conductivity, catalytic combustion, and colorimetry, was investigated. This study showed that simple, fieldable instruments are available, or can readily be made available, for detecting spills of most common, hazardous materials at (or near) the threshold for deleterious biological effects. Several applicable commercial instruments were identified. A novel apparatus employing chemical indicators was developed for the early warning of spills of a wide range of pollutants in natural water bodies. A prototype spill-tracing kit was designed and fabricated for use by laymen, and its effectiveness was demonstrated with volunteer firemen as operators.

This report was submitted in fulfillment of Contract Nos. 68-01-0110 and 68-03-0287 by Calspan Corp. under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period June 30, 1971, to February 25, 1974, and work was completed as of March 20, 1974.

Bohme, G.

TREATMENT OF SOLID RADIOACTIVE WASTE
Karlsruhe Nuclear Research Center, IAEA Interregional Training Course, September-October 1982.

The primary incentive for compacting waste is the savings resulting from volume reduction. Cost savings can be made for containers, interim storage, shipment, and final disposal.

Mechanical compaction has been used extensively in the nuclear industry for the consolidation of dry, active waste.

Possible processes are pressing, rolling, shredding, stamping, extrusion, and explosive forming. However, to date, only the first three have been applied for nuclear wastes because the criteria regarding the equipment utilized must include factors, such as:

1. dust generation (contamination spread out, increased fire and dust explosion hazards),
2. reliability,
3. maintenance,
4. efficiency,
5. susceptibilty to contamination problems, and
6. bale-handling problems (loading and unloading).

Borham, M.

INCINERATION METHOD FOR VOLUME REDUCTION AND DISPOSAL OF TRANSURANIC WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., The Ralph M. Parsons Co., March 1985.

The Process Experimental Pilot Plant (PREPP) at Idaho National Engineering Laboratory (INEL) is designed to process 7 TPD (6.4 Mg/d) of transuranic (TRU) waste, producing 8.5 TPD (7.7 Mg/d) of cemented waste and 110 m^3/min (at standard conditions) of combustion gases with a volume reduction of up to 17:1. The waste and its container are shredded, fed to a rotary kiln heated to 925°C, and then cooled and classified by a trommel screen. The fine portion is mixed with a cement grout, which is placed with the coarse portion in steel drums for disposal at the Waste Isolation Pilot Plant (WIPP).

The kiln off-gas is reheated to 1090°C to destroy any remaining hydrocarbons and toxic volatiles. The gases are cooled and passed in a venturi scrubber to remove particulates and corrosive gases. The venturi off-gas is passed through a mist eliminator and is reheated to 28°C above the dew point prior to passing through a High Efficiency Particulate Air (HEPA) filter. The scrub solution is concentrated to 25% solids by an inertial filter. The sludge, containing the combustion chemical contaminants, is encapsulated with the residue of the incinerated waste.

Bourduin, L. C.; Neuls, A. S.

COMMERCIAL INCINERATION DEMONSTRATION
LA-UR-81-3494, Los Alamos National Laboratory, 1981.

Low-level radioactive wastes (LLRW) generated by nuclear utilities presently are shipped to commercial burial grounds for disposal. Substantially increasing shipment and disposal charges have sparked renewed industrial interest in incineration and other advanced volume-reduction techniques as potential cost-saving measures. Repeated inquiries from industry sources regarding LLRW applicability of the Los Alamos controlled-air incineration (CAI) design led DOE to initiate this commercial demonstration in FY-1980. The selected program approach to achieving CAI demonstration at a utility site is a DOE-sponsored joint effort involving Los Alamos, a nuclear utility, and a liaison subcontractor. Required development tasks and responsiblities of the participants are described. Target date for project completion is the end of FY 1985.

Bourduin, L. C.; Taboas, A. L.

PLANT SAFETY FEATURES
Nuclear Safety, Vol. 22, No. 1, pp. 56-69, January-February 1981.

The current inventory of low-level radioactive waste (radwaste) from defense and commercial industries is 2×10^6 m^3 and increases 10^5 m^3/year due to current operations. Most of this waste can be classified as combustibles, liquids and sludges, or noncombustible solids. The substantial combustible fraction, which has the greatest potential for effective waste treatment, constitutes an average of 40% of the newly generated waste. Proper incineration reduces waste mass and volume, results in a more homogeneous and chemically inert waste form, and also enhances the safety and certainty of waste handling, packaging, and storage and/or disposal operations. This article presents an introduction to incineration concerns and an overview of the prominent radwaste incineration processes being developed within the Department of Energy. Brief process descriptions, the status and goals of individual incineration systems, and planned or potential applications are also included.

Bourduin, L. C.; Taboas, A. L.

U.S. DOE RADIOACTIVE WASTE INCINERATION TECHNOLOGY: STATUS REVIEW
Los Alamos Scientific Laboatory, March 17, 1980.

The current inventory of radioactive waste from the defense and commercial industries is 2 x 10^6 m^3 and increase 10^5 m^3/year due to current operations. Most of this waste can be classified as combustibles, liquids and sludges, or as noncombustible solids. The very substantial combustible fraction, which has the greatest potential for effective waste treatment, constitutes an average of 40% of the newly generated waste. Proper incineration reduces waste mass and volume and results in a more homogeneous and chemically inert waste form that can usually be disposed where the original waste form could not. Further, incineration significantly enhances the safety and certainty of waste handing, packaging, storage, and/or disposal operations.

This paper presents an introduction to incineration concerns, and an overview of the prominent radwaste incineration processes being developed within DOE. Brief process descriptions, status and goals of individual incineration systems, and planned or potential applications are included.

Bowerman, B. S.; Swyler, K. J.; Dougherty, D. R.; et al.

AN EVALUATION OF THE STABILITY TEST RECOMMENDED IN THE BRANCH TECHNICAL POSITION ON WASTE FORMS AND CONTAINER MATERIALS
NUREG/CR-3829, Brookhaven National Laboratory, May 1984.

Several vendors of low-level waste solidification technology were contacted to obtain representative ANS 16.1 leach test data for this study. Only Chem-Nuclear Systems, Inc. (CNSI), had data available at the time of this writing. In the absence of ANS 16.1 data for bitumen and vinyl-esterstyrene, and to augment the cement results, selected IAEA leach test data were assembled from the literature. While the test durations and sampling intervals in these IAEA tests may vary substantially from those prescribed in ANS 16.1, an ANS 16.1 treatment of these IAEA test data should provide a reasonable test of the analysis' capabilities; it should also provide a reasonable insight into the range of results that may be expected when ANS 16.1 testing is reported. The majority of the data reviewed was for the cement binder. This reflects the dominance of cement as the binder of choice in the nuclear industry. In the sections of the report, results of the ANS 16.1 data treatment are presented. Additionally, in some cases, the results of the alternate graphical treatment are presented.

Brewton, B. J.

HAZARDOUS WASTE REDUCTION, TREATMENT, AND DISPOSAL: AN OVERVIEW
Pennsylvania Environmental Research Foundation, September 1983.

This paper was written to provide citizens with information concerning hazardous waste reduction, treatment, and disposal technologies. It seeks to reduce technical jargon and convey information clearly and accurately. Chapter 1 provides a framework for understanding the hazardous waste issue, addresses the negative attitude prevalent among some citizens and cities, and explains the importance of well-constructed, environmentally sound facilities that will implement technologies to reduce, treat, and dispose of hazardous waste.

Chapter 2 reviews processes by which the amount of hazardous waste produced by a generating source can be reduced through modification of in-house manufacturing processes. Chapter 3 discusses physical, chemical, thermal, and biological treatment techniques which simply reduce the volume of hazardous waste requiring further treatment and disposal. Chapter 4 describes methods used for the disposal of hazardous wastes. The conclusion discusses the development of alternative technologies for managing hazardous waste.

Browne, H. L.

THE STATUS OF FUEL REPROCESSING IN THE UNITED STATES
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 76-83, August 26-29, 1984.

The processing of commercial nuclear fuel in the United States appears to be only a remote possibility for the remainder of this decade, and possibly for the remainder of this century. The impediments to reprocessing have been primarily institutional and economic rather than technical. A review of the reprocessing industry will be presented, showing the major activities during the past few years which have had significant impact on its progress. The economics of reprocessing will be discussed, showing that at present uranium prices and with reasonable waste disposal costs for spent fuel, fuel recycle may not be economical for years to come.

Incentives for reprocessing will be represented. These incentives include the recycle of plutonium in light-water reactors, the use of plutonium in a revitalized United States breeder program, and reprocessing as an alternative for the disposal of high-level waste.

Brownstein, M.

ATCOR/KRAFTANLAGEN PYROLOYSIS INCINERATOR
"Incineration of Low-Level Radioactive Wastes: 1985," Lecture Notes, Tucson, Arizona, March 21, 1985, p. B1.

This paper provides the current status of the Nuclear Regulatory Commission (NRC) licensing for the Battelle Memorial Institute's low-level waste incineration program. The incinerator, originally designed by Kraftanlagen for the Jülich Research facility in West Germany, is licensed to be manufactured and sold in the United States by ATCOR Engineered Systems, Inc., of Avon, Connecticut.

In December 1984, Battelle submitted a final series of responses to the NRC for a license to operate a low-level waste incinerator. An NRC construction and operating permit is expected this spring. The incinerator is the focal point of a research and demonstration program investigating the technical and economic feasibility of a central site incinerator. The ATCOR/Kraftanlagen process was selected by Battelle for this program.

This paper contains a detailed process description and a review of the current licensing status of the ATCOR/Kraftanlagen pyrolysis incinerator.

Brownstein, M; Levesque, R. G.

EXPERIENCE WITH CEMENT USAGE AS THE BINDING AGENT FOR RADWASTE
The American Society of Mechanical Engineers, April 7, 1978.

Much of the confusion that exists in the radwaste solidification field is due to poor communication between chemists, who propose exotic solidification agents and the design engineers, who have had to incorporate them into working systems. This paper seeks to improve the communications by explaining how cement systems function in solidifying typical radioactive waste streams. Through understanding these basic principles, the design of a highly efficient waste system has been possible. Experience has shown this system to be extremely reliable in the operating environment of nuclear power plants and has produced a product which has been universally accepted at commercial burial sites.

Brownstein, M.; Witt, L.

INCINERATION OF LOW-LEVEL RADIOACTIVE MATERIAL
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., March 1985.

An advanced controlled-air pyrolysis incinerator has been developed and placed into operation for low-level radioactive wastes and has demonstrated the capability to incinerate ion-exchange resin. The resin incineration program has proven the ability of the incineration process to successfully incinerate varying mixtures of low-level, dry, active wastes and spent ion-exchange resins while maintaining off-gas contamination well below limits set by regulatory authorities.

Both commercial and nuclear installations have been operated, with the most recent application being a central incinerator for low-level radioactive waste presently being licensed in the United States. The NRC license for this facility is expected in mid-1984. This incinerator will process two million pounds (909 Mg) of dry, active waste and ion-exchange resin per year.

Buelt, J. L.

A MOBILE ENCAPSULATION AND VOLUME REDUCTION SYSTEM FOR WET LOW-LEVEL WASTES
PNL-SA-12777, Pacific Northwest Laboratory, December 1984.

This presentation describes the preliminary results of the program entitled "A Preconceptual Study for a Transportable Vitrification Process." The objective of the study was to determine the feasibility of a mobile encapsulation and volume reduction system (MEVS). The objective of the program is being accomplished by formulation of design criteria, preparation of a preconceptual design of the system, a comparison of disposal costs with other solidification technologies, and an assessment of utility interests in the transportable volume reduction service MEVS can provide. The MEVS design employs the use of a Joule-heated glass melter to convert the wet low-level wastes into glass. Not only is the waste converted to a stable, geologic disposal form, but a high volume reduction is also achieved. The process is completely self-sufficient, requiring no direct facility services or reactor personnel. It is capable of servicing one waste type from a minimum of three reactors. It can process 360 m^3/year of resins or 1080 m^3/year of concentrated liquid. MEVS costs compared favorably with estimates of alternative solidification processes when compared on an equivalent basis.

Buelt, J. L.; FitzPatrick, V. F.; Timmerman, C. L.

ELECTRICAL TECHNIQUE FOR IN-PLACE STABILIZATION OF CONTAMINATED SOILS
Chemical Engineering Progress, Vol. 81, No. 3, pp. 43-48, March 1985.

In-situ vitrification (ISV) is an emerging technology that is currently being tested for the potential in-place stabilization of radioactive, tranuranic wastes at Pacific Northwest Laboratory. The process is being developed to convert contaminated soils into a stable glass and crystalline waste form that has chemical durability properties similar to granite. Although ISV is not a panacea for all contaminated soils, it does have numerous potential advantages:

1. Long-term stabilization of radioactivity (>10,000 year).
2. Cost effectiveness ($160 to $330/m^3).
3. Applicability to varying soil and conditions.
4. Minimal occupational exposure to the waste during processing.
5. Low energy requirements (<1 kW/kg).

Camougis, G.

TOXIC MATERIALS RISK ASSESSMENT: A PRACTICAL GUIDE
Pollution Engineering, pp. 50-57, August 1985.

Although a variety of risk assessment procedures have been developed in recent years, there is no single procedure which has received universal acceptance, especially for application to toxic materials. There are so many different laws and regulations and so many regulatory objectives that no universal method has been developed and accepted for risk assessment. However, during the past few years, there has been significant progress in the development of various methods to assess risks related to toxic contaminants in pollution engineering. Much of this progress is related to the application of the systems approach to risk assessments of toxic materials. The systems approach has been applied to various engineering projects for many decades. Recently, it has also been applied to environmental contamination problems. Subjects discussed in a systems approach to risk assessment are as follows: (1) laws and regulations, (2) liabilities, (3) information on hazardous materials, (4) hazards, (5) risks to humans, (6) financial risks, (7) decisions, and (8) risks to environment.

Cangini, D.; Cordier, J.

DESIGN, MANUFACTURING AND COMMISSIONING OF MOBILE UNIT FOR EDF (DOW CHEMICAL PROCESS)
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 263-65, March 1985.

To process their spent ion-exchange resins and the liquid wastes, EDF has ordered to PEC a mobile unit using the Dow Chemical binder.

This paper presents the EDF's design requirements, as well as the new French regulation for waste embedding.

The mobile unit was started in January 1983 and commissioned successfully in January 1985 in the TRICASTIN EDF's power plant.

Cannon, J. B.; Fields, D. E.; Kocher, D. C.; Lee, D. W.

GENERIC ASSESSMENT OF ALTERNATIVES FOR GCD OF ICT WASTE
Oak Ridge National Laboratory, June 28, 1985.

The purpose of this study is to provide a generic assessment of GCD options available for application to ICT waste. The assessment is based on available information developed for GCD of TRU and low-level radioactive waste (LLRW). The assessment considers the characteristics of special-case TRU wastes that may be classified as ICT waste after the completion of site inventory-work-off plans (IWOP) and the finalization of WIPP-WAC. The available GCD technology options are identified, and the advantages and disadvantages of each technology are discussed. A methodology for selecting GCD technologies to formulate a GCD system for ICT waste is presented. The applicability of GCD to ICT wastes is discussed, along with the regulatory constraints associated with TRU waste disposal. The generic assessment and the decision methodology presented in this report will be applied to the Oak Ridge Reservation for special-case TRU wastes stored at ORNL in the forthcoming final report associated with this project.

Carley-MacAuly, K. W.

OPTIONS FOR THE TREATMENT OF LOW- AND INTERMEDIATE-LEVEL ACTIVE LIQUID WASTES
IAEA-CN-43/21, IAEA Radioactive Waste Management, UKAEA Atomic Energy Research Establishment, pp. 15-35, 1984.

The accepted objective in treating waste liquid is to reduce activity in the bulk water to a level suitable for local discharge while concentrating nearly all the active species, usually in a from suitable for immobilization, for storage and disposal. The primary methods of treatment generally used in the nuclear industry are: (1) evaporation; (2) chemical precipitation; and (3) ion exchange, together with filtration. Recent studies have been made of liquid treatment processes under the auspices of the IAEA and the CEC. The latter were particularly concerned with more-advanced processes, including developments in precipitation techniques, use of inorganic ion exchangers and other novel absorbents, membrane separations, electrical processes, and high-gradient magnetic separation. The present paper aims to summarize the current state of treatment processes that are available now, or are becoming available, and to relate them to the developing scene for further conditioning of waste for storage or disposal.

Carol, D.; Rubin, K.

HAZARDOUS WASTE MANAGEMENT: RECENT CHANGES AND POLICY ALTERNATIVES
Congress of the United States/Congressional Budget Office, May 1985.

The development and implementation of a long-term solution to the nation's hazardous waste problem are of paramount concern to federal and state governments. Following important changes to hazardous waste laws in 1984, the Congress is now considering further refinements to the federal system for hazardous waste management. In view of these activities, this study: (1) examines the current picture of hazardous waste generation, management, and costs; (2) evaluates recent changes to the federal law regulating hazardous waste; and (3) analyzes additional options for improving federal regulations, with an emphasis on taxes on wastes and their feedstock precursors.

The options examined in this paper address three Congressional objectives: (1) reduction or elimination of the generation of hazardous waste; (2) effective treatment, storage, and disposal of hazardous waste to eliminate the possiblity of future problems; and (3) provision of sufficient financial resources to support government action protecting public health and the environment from uncontrolled waste disposal sites, toxic waste spills, or other hazardous discharges.

Carter, B. R. (Editor)

CODE OF FEDERAL REGULATIONS - PROTECTION OF ENVIRONMENT - TITLE 40
40 CFR 190.01 Parts 190 to 399, Office of the Federal Register, July 1, 1984.

The Code of Federal Regulations is a codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the federal government. The Code is divided into 50 titles which represent broad areas subject to federal regulation. Each title is divided into chapters that usually bear the name of the issuing agency. Each chapter is further subdivided into parts covering specific regulatory areas.

Title 40 - Protection of Environment is composed of nine volumes. The contents of these volumes represent all current regulations codified under this title of the CFR as of July 1, 1984.

Chapter I - Environmental Protection Agency appears in all nine volumes.

Carter, T. J.; Rao, P. K. M.

FIFTEEN YEARS OF RADIOACTIVE WASTE MANAGEMENT
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 445-51, March 1985.

Ontario Hydro is a large Canadian utility producing 84% (7394 MWe) of the nuclear electricity generated in Canada. The low- and intermediate-level radioactive wastes generated by the Ontario Hydro program are currently being managed at the Bruce Nuclear Power Development with various volume reduction, packaging, and interim storage systems. Ontario Hydro also owns and operates a radioactive waste transportation system. Studies are in progress for final disposal of these wastes in a suitable geology in Ontario. Since its inception in 1971, Ontario Hydro's radioactive waste management program has evolved into providing a full-fledged radioactive waste management capability to the utility's two nuclear generation centers at Pickering and Bruce and, later in the decade, to Darlington. This paper summarizes the various developments in this program, highlights the major facilities both in-service and planned to be built, reviews the experiences gained over 15 years of in-house waste management, and discusses the proposed reorientation toward ultimate disposal of these wastes.

Casler, J.; Ramsey, S.

SUPERFUND HANDBOOK, FIRST EDITION
Environmental Research and Technology, June 1985.

This handbook serves as a brief guide and provides a general overview of CERCLA ("Superfund") and the National Contingency Plan (NCP). It does not, however, deal with cleanup of oil spills, the original impetus for the NCP. Rather, the handbook focuses on federal Superfund legislation and its potential impacts on those responsible for sites where hazardous releases have occurred, or may occur.

The following is a quick profile of the specific sections:

1. Glossary of Key Terms
2. Overview of CERCLA
3. The National Contingency Plan
4. Response Actions and Procedures Under the NCP
5. Proposed Revisions to the NCP
6. Managing Response to CERCLA
7. EPA's Evolving Settlement Policy

Cecille, L.; Simon, R.

TREATMENT AND CONDITIONING PROCESSES FOR LOW- AND MEDIUM-ACTIVITY WASTE
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 516-25, August 26—29, 1984.

Under the European Communities "R and D Programme on Management and Disposal of Radioactive Waste," various treatment and conditioning processes for the management of alpha waste in line with different objectives (i.e. volume reduction, splitting of activity, direct conditioning) are being developed and assessed. For liquid waste, these involve the use of solvent extraction, inorganic ion exchangers, and chemical precipitation, possibly combined with denitration or ultrafiltration. Regarding plutonium-contaminated solids, the processes deal with acid digestion, simple leaching or washing, high-temperature incineration, and pyrolysis/char oxidation. The scope and respective performance of each of these processes are presented.

Chan, D. W.; et al.

SELECTION AND EVALUATION OF POTENTIAL VERY-LOW-LEVEL WASTES (VLLW) FROM NUCLEAR POWER PLANTS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 395-99, March 1985.

The disposal of very-low-level radioactive waste (VLLW) generated by light water reactors presents a significant problem to the nuclear utility industry. The National Environmental Studies Project of the Atomic Industrial Forum has sponsored a study to develop and summarize information on VLLW to support deregulation of streams that pose negligible hazards. This paper presents preliminary results of this study, describes the methodology used in selecting candidate streams for detailed analysis, and estimates radiation doses from the disposal of these wastes. The study is divided into several sections, which describe (1) the concept of regulatory cutoffs and its application to radioactive waste disposal, (2) the selection criteria for VLLW candidate streams, (3) the selection of candidate VLLW streams for study, (4) the potential disposal methods for VLLW, (5) limiting activities for various threshold dose levels, and (6) preliminary conclusions or recommendations available from the study. The results of the study described will be available as a technical document which can be used in support of a petition for exemption or rulemaking to NRC relating to a particular or generic waste stream.

Chandler, J. M.; Milford, R. P.; Pietrzak, B. D.; du Mont, S. P.

A COMPARISON OF COSTS FOR TREATMENT AND STORAGE OR DISPOSAL OF LOW-LEVEL SOLID RADIOACTIVE WASTES AT ORNL
ORNL/TM-8092, Oak Ridge National Laboratory, May 1982.

Costs for solid low-level radioactive waste treatment steps and disposal operations were developed for ORNL-generated LLRW. Costs for various combinations of waste treatment process steps, packaging, and disposal options are presented. The cost study was based around an existing ORNL facility using the quantity and type of LLRW generated at ORNL. The capital cost estimates included a capital recovery factor based on capital recovery in 20 years, 10% annual interest, and levelized payments. The overall costs for waste treatment and disposal varied from \$40 to \$1740 per ft^3 (\$1412 to \$61,440 per m^3) of initial solid waste volume. The storage/disposal costs ranged from \$0.11 to \$24/ft^3 (\$3.90 to \$850 per m^3). The lower costs were for Type I rubble waste with minimum processing and disposal operations; the higher costs were for Type II combustible waste with incineration followed by ash disposal in a concrete box in a concrete vault. The major factor in almost all cases considered was capital costs. Capital costs for complex waste treatment processes, account for greater than 90% of the overall costs and resulted in the highest total expenditures. These estimates may be used to identify the more economical options available for future use at ORNL.

Chant, D. A.

OWMC PHASE 2 REPORT SUMMARY - CHAIRMAN'S REPORT
Ontario Waste Management Corporation, Janaury 1983.

This summary of OWMC's Phase 2 Report presents the major findings and decisions arrived at during the second phase of our Facilities Development process. The report signals two important decision points: (1) important planning principles regarding the nature and scope of waste treatment facilties needed, and (2) the geographic region in Ontario to be studied for location of waste treatment facilities.

It has been concluded that OWMC must design facilities that can handle and treat all types of special wastes to the fullest possible extent. Any remaining residues must receive the most secure containment. On this basis, the treatment system should consist of an incinerator, a physical/chemical treatment plant that includes a solidification facility, and a secure landfill. The system should be large enough to handle a significant portion of Ontario's special waste production but sized to avoid wasteful excess capacity.

The site search has been narrowed to the Golden Horseshoe region at the western end of Lake Ontario.

Chemical Industry Safety and Health Council

A GUIDE TO HAZARD AND OPERABILITY STUDIES
Chemical Industry Safety and Health Council, 1981.

A hazard and operability study is defined in the British Chemical Industry Safety Council publication Safety Audits in the following manner: "The application of a formal systematic critical examination to the process and engineering intentions of the new facilities to assess the hazard potential of maloperation or malfunction of individual items of equipment and the consequential effects on the facility as a whole."

The technique aims to stimulate the imagination of designers in a systematic way so that they can identify the potential hazards in a design. It can be applied to all types of plants within the industry ranging from large continuous ones, such as petrochemical or ammonia plants, through small batch units to individual proprietary items of equipment, such as autoclaves or machines for making sheets of plastic. The technique can be used by small organizations as well as by large ones.

This guide introduces the technique and the chapters have been arranged, first, to convey the basic principles of the technique and, then, to place it in context.

Chem-Nuclear Systems, Inc.

BARNWELL LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY RATE SCHEDULE
Chem-Nuclear Systems, Inc., January 1, 1985.

This schedule gives the present rate of use of the disposal facility in Barnwell County and the rate effective as of April 1, 1985. Included in the rate are the following charges:

1. Base Disposal Charges
   A. Standard Waste
   B. Biological Waste
   C. Special Nuclear Material (SNM)

2. Surcharges
   A. Weight Surcharges (crane loads only)
   B. Curie Surcharge

3. Other charges
   A. Cask Handling Fee
   B. Taxes and Special Funds

Also included are general miscellaneous facts about the use of the facility in Barnwell County.

Chem-Nuclear Systems, Inc.

DECONTAMINATION
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Decontamination is vitally important to the nuclear industry. Correctly applied, decontamination can provide an effective program for the reduction of both radwaste volume and personnel exposure. No single method of decontamination can solve every problem. While Chem-Nuclear can place decontamination units inside nuclear facilities where space is available, most utilities today want the convenience of a self-contained mobile unit. Some of the decontamination processes used are: (1) Vaqua-Decon - features a high-volume liquid/abrasive consisting of solid media (glass beads or other abrasives) in water; (2) Electro-Con - decontaminates by removing a thin layer of surface metal; and (3) Freon Ultrasonic Vapor Degreasing - applicable to rubber and metal components with electrical parts. In addition to these three methods, Chem-Nuclear provides a complete range of other decontamination technologies, including high-pressure Freon, vibratory finishing, hydrolasing, and chemical decontamination.

Chem-Nuclear Systems, Inc.

DEMINERALIZATION
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Chem-Nuclear provides both routine and emergency demineralization services to nuclear facilities throughout the United States. These services include all types of ion-exchange and filtration-radwaste processing, spent fuel pool purification, component dechromating, and cooling water purification. Because each demineralization job has a different feed stream chemistry, system effluent specifications, and required flow rates, Chem-Nuclear tailors each application of demineralization technology to the individual requirements of the customer.

The mobile system contains three major components: the control skid, process vessels, and shielding. Chem-Nuclear mobile systems use both disposable process vessels or permanent, sluicable vessels, both of which allow for minimizing the handling of radioactive materials.

Chem-Nuclear Systems, Inc.

FUEL POOL SERVICES
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

In the immediate future and years to come, the management of spent fuel pools will be one of the most demanding areas of radioactive waste management technology. Pools originally designed for short-term spent fuel storage have reached, or are reaching, their capacity and require substantial upgrading. This brochure describes the research and development that Chem-Nuclear has done on the subject. Some of Chem-Nuclear's state-of-the-art equipment in use today includes: (1) Hydraulic Cutter - used, mainly, to cut pipe and cold ends of LPRMs; (2) LPRM Cutter - has shearing strength of 200,000 psi (1.4 GPa); (3) Hydro Vacuum - used to clean and circulate spent fuel pool water while work is in progress; (4) Crusher/Shearer - used primarily for crushing and cutting fuel channels; (5) Plasma-Arc Cutter - cuts underwater to depths of 40 feet (12 m); (6) Underwater Saw - designed to cut control-rod blade guides, but can be modified to cut any other material up to 1 in. in thickness.

Chem-Nuclear Systems, Inc.

THE LEADER IN NUCLEAR WASTE MANAGEMENT TECHNOLOGY
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Over the last decade, a dedicated team of management and technical professionals has succeeded in establishing Chem-Nuclear as the leader in low-level radioactive waste management. In fact, much of today's radwaste management technology is a direct result of Chem-Nuclear's continuing efforts to better serve the nuclear industry. In response to the special needs of the nuclear industry, Chem-Nuclear has developed high-integrity containers, specialized resin dewatering containers, advanced decontamination systems, and unique underwater cutting and packaging technologies. They provide service in the following areas: transportation, specialized disposal containers, solidification, demineralization, decontamination, fuel pool services, decommissioning, and technical consulting. A general description of each of these services is offered in this brochure. ATCOR Engineered Systems, Inc., recently became a Chem-Nuclear subsidiary. ATCOR provides a wide range of specialized inplant systems for radwaste processing and handling. ATCOR holds technical agreements with Belgonucleaire, SA, of Belgium and Kraftanlager, AG, of West Germany.

Chem-Nuclear Systems, Inc.

LIQUID VOLUME REDUCTION - THE GEODE SYSTEM
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Chem-Nuclear introduces the GEODE System, a new concept in nuclear waste management services. . .the integration of two proven waste management technologies to provide one comprehensive system. The GEODE System is a combination of technologies employing an HPD Mobile Crystallizer Unit for liquid volume reduction, a Chem-Nuclear Mobile Cement Solidification Unit for liquid volume reduction, and a Chem-Nuclear Mobile Cement Solidification Unit for stabilization of the concentrated waste. The System is essentially self-contained, requiring only minimal plant-supplied utilities. . .electricity, air, and water. It is composed of all-weather, state-of-the-art equipment modules. . .field proven in power plants around the world.

Chem-Nuclear Systems, Inc.

MOBILE WASTE SOLIDIFICATION
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Chem-Nuclear's extensive research and development program has determined that the successful immobilization of radwaste with cement requires a unique chemical process. The appropriate chemistry requires various additives and distinct reaction times for each waste type. Chem-Nuclear's cement formulas in use today have been tailored to each waste stream to achieve an economical process that meets all the requirements of 10 CFR 61. Chem-Nuclear's cement solidification chemistry provides for acceptable immobilization of all utility radwaste streams, including resins, diatomaceous earth, oil, acids, decontamination solutions, etc. In fact, Chem-Nuclear has successfully solidified these waste types at over 20 utility sites.

Chem-Nuclear's Mobile Cement Solidification Unit provides versatility. Besides solidifying all forms of aqueous wastes, this full-size unit can also encapsulate filters, or when mated with our shredder, can reduce filter volumes while solidifying radwaste. Dewatering of bead resin, powdered resin, Solka-floc, diatomaceous earth, and other filter sludges can be accomplished with this same system.

Chem-Nuclear Systems, Inc.

SPECIALIZED DISPOSAL CONTAINERS
Chem-Nuclear Systems, Inc., Promotional Brochure, circa 1984.

Some of the different types of disposal containers produced by Chem-Nuclear are: (1) carbon-steel containers, (2) high-integrity containers, and (3) high-integrity container overpacks.

Chem-Nuclear's specialized disposal containers are available with a variety of filter assemblies and other internals, depending on their use by the customer. Some of the uses for which internals can be provided are:

1. waste stream processing;
2. dewatering of bead resins, powdered resins, fibrous resins, filter sludge, and diatomaceous earth;
3. solidification of bead and powdered resins, oil, and liquid waste such as evaporator bottoms; and
4. use as disposable demineralizers.

Chem-Nuclear Systems, Inc.

TOPICAL REPORT - MOBILE CEMENT SOLIDIFICATION SYSTEM - VERSION 2
Chem-Nuclear Systems, Inc., CNSI-2, January, 1983.

The report describes the design and operation of the Chem-Nuclear Systems, Inc. (CNSI) Mobile Cement Solidification System (MCSS), which combines wet radwastes preconditioned with additives with dry cement to obtain complete solidification for eventual offsite shipment to a licensed burial facility. In addition, the report describes process parameters and the system design features for developing and implementing a process control program to reasonably assure complete solidification of process wet radwaste and the absence of free water in the solidifided products. The principal findings are: (1) the MCSS is capable of safely processing and solidifying wet radioactive wastes generated by light water reactors; (2) the acceptable process parameters and the system design features are provided for implementing a process control program to reasonably assure that the solid waste product is a homogeneous mixture of process waste in a cement binder and contains no free water; (3) there are no direct releases of radioactive material in gaseous and liquid effluents to the environment; and (4) the system design includes radiation protection measures to ensure that occupational exposure to personnel is kept as low as possible.

Chiu, S.; Newsom, B. S; Humphrey, J.; et al.

TECHNOLOGICAL OPTIONS FOR MANAGEMENT OF HAZARDOUS WASTES FROM
U.S. DEPARTMENT OF ENERGY FACILITIES
ANL/EES-TM-235, Argonne National Laboratory, August 1982.

This report provides comprehensive information on the technological options for management of hazardous wastes generated at facilities owned or operated by the U.S. Department of Energy (DOE). These facilities annually generate a large quantity of wastes that could be deemed hazardous under the Resource Conservation and Recovery Act (RCRA).

Nearly 20 unit processes and disposal methods are presented in this report. They were selected on the basis of their proven utility in waste management and potential applicability at DOE sites. These technological options fall into five categories: (1) physical processes, (2) chemical processes, (3) waste exchange, (4) fixation, and (5) ultimate disposal. The options can be employed for either resource recovery, waste detoxification, volume reduction, or perpetual storage. Detailed descriptions of each technological option are presented, including information on process performance, cost, energy and environmental considerations, waste management of applications, and potential applications at DOE sites.

Clark, D. E.; Colombo, P.; Neilson, R. M., Jr.

SOLIDIFICATION OF OILS AND ORGANIC LIQUIDS
BNL-51612, Brookhaven National Laboratory, July 1982.

The suitability of selected solidification media for application in the disposal of low-level oil and other organic liquid wastes has been investigated. In the past, these LLWs have commonly been immobilized by sorption onto solid absorbents, such as vermiculite or diatomaceous earth. Evolving regulations regarding the disposal of these materials encourage solidification. Solidification media that were studied include Portland type I cement; vermiculite plus Portland type I cement; and Nuclear Technology Corporation's Nutek 380-cement process, etc. Waste forms have been evaluated as to their ability to reliably produce freestanding monolithic solids which are homogeneous (macroscopically), contain <1% freestanding liquid, by volume, and pass a water immersion test. Solidified waste forms were also subjected to vibratory-shock testing and flame testing. Simulated oil wastes can be solidified to acceptable solid specimens having volumetric waste loadings of less than 40 vol %. However, simulated organic liquid wastes could not be solidified into acceptable waste forms above a volumetric loading factor of about 10 vol % using the solidification agents studied.

Clark, J. H.; Sneed, B. J.

PROJECTION OF LOW-LEVEL WASTE VOLUMES FROM DECOMMISSIONING OF COMMERCIAL NUCLEAR POWER REACTORS
DOE/LLW-26T, EG&G Idaho, Inc., January 1984.

The main objective of this project is to develop the capability to project the low-level waste volumes from the decommissioning of U.S. commercial nuclear power reactors. Seventy-seven reactors are now operating, or have operated, in the United States, and 70 more are expected to be operating by the year 2000. The large-scale decommissioning of U.S. commercial nuclear power reactors will begin about the year 2000 and is expected to continue beyond 2045. The low-level wastes from decommissioning of these facilities must be accommodated in emerging state and regional low-level waste disposal sites. Accurate projections of the annual decommissioning waste volumes must be available for developing disposal site plans. The decommissioning waste volume information will be available from an existing computerized information management system for the National Low-Level Radioactive Waste Management Program. Section 2 of this report summarizes the approach for compiling data and calculational techniques. Section 3 lists the U.S. commercial nuclear power plants, both planned and presently operating. Section 4 describes decommissioning modes, and Section 5 details waste inventory projections.

Clark, W. E.

THE USE OF ION-EXCHANGE TO TREAT RADIOACTIVE LIQUIDS IN LIGHT-WATER COOLED NUCLEAR REACTOR POWER PLANTS NUREG/CR-0143 (ORNL/NUREG/TM-204) Oak Ridge National Laboratory, (Addendum to ORNL-4792), August 1978.

This study was made to update an existing report on the current and future uses of ion exchange as a method for treating liquid radioactive waste streams at light-water reactor (LWR) power plants. Data were obtained from questionnaires sent to nuclear power plants, architect-engineering firms, and equipment suppliers. These data were supplemented by personal communications and, in a few cases, by information extracted from company reports. Detailed results obtained from responses received from the operators at 14 boiling water reactors (BWRs) and 19 pressurized water reactors (PWRs) are tabulated in the Appendix. No significant changes in practice are evident since the issuance of the basic report, "Use of Ion Exchange for the Treatment of Liquids in Nuclear Power Plants" (ORNL-4792), in 1973. On the other hand, a trend toward eliminating resin regeneration even with condensate polishers and with PWR deborating resin beds has been observed. Summary tables are presented for average decontamination factors (DFs) and for volumes and activities of the spent resin generated by operating reactors. A list of recommendations for improving the efficiency of the ion-exchange process is also included.

Clements, T. L. Jr., et al.

PROCESSING AND CERTIFICATION OF DEFENSE TRANSURANIC WASTE AT THE INEL Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 526-37, August 26–29, 1984.

Since 1970, defense-generated transuranic waste has been placed into 20-year retrievable storage at the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory (INEL). A major objective of the U.S. Department of Energy (DOE) Nuclear Waste Management Program is to remove all retrievable stored transuranic waste from the INEL.

To support this objective, the Stored Waste Examination Pilot Plant (SWEPP) and the Process Experimental Pilot Plant (PREPP) are currently being constructed. SWEPP will certify waste, using nondestructive examination techniques, for shipment to the Waste Isolation Pilot Plant (WIPP). PREPP will process uncertifiable waste into a certifiable waste form.

Clerman, R.

AQUATIC MONITORING OF RADIONUCLIDES AT U.S. NUCLEAR POWER PLANTS ON ESTUARIES
MTR-83W117, The MITRE Corporation, July 1983.

Radiological monitoring of the aquatic environment at U.S. nuclear power plants located on estuaries is surveyed. The U.S. Nuclear Regulatory Commission outlines the requirements for monitoring, and power plant operators develop monitoring programs suited to the particular conditions of their facilities. Based on a survey of 13 power plants on estuaries and a detailed review of three case studies, it appears that monitoring is effective in verifying that radionuclides are not present at hazardous levels in human exposure pathways (water, sediments, plants, invertebrates, fish). The majority of sample measurements above background are below standards for protection of human health.

Click, J. L.

EFFECTS OF TEMPERATURE AND DISSOLVED OXYGEN ON SULFUR DIOXIDE REQUIREMENT FOR HEXAVALENT CHROMIUIM REDUCTION
GAT-T-2196, Goodyear Atomic Corporation, April 1974.

The bulk of the water pollutants present in Portsmouth's wastewater effluents can be attributed to two sources: blowdown from the recirculating cooling water (RCW) system, and effluent from the X-710B Holding Pond (HPW). Some of the most commonly found pollutants are chromium (Cr), zinc (Zn), copper (Cu), phosphates (PO_4), and sulfates (SO_4) in the RCW and aluminum (Al), chlorides (Cl), fluorides (F), and nitrates (NO_3) in the HPW. The RCW and HPW effluents will be blended before treatment in the proposed Central Liquid Waste Treatment Facility. The new facility will employ the reduction-precipitation method for removal of chromates and other dissolved solids. Reduction of hexavalent chromium (Cr^{6+}) to less than 0.05 ppm (0.05 mg/L) as required by law and the removal of other reducible species will be accomplished by the addition of the chemical reductant sulfur dioxide (SO_2). Precipitation occurs on addition of lime (CaO), which forms insoluble metal hydroxides. The work described herein involves the optimization of the reduction step, i.e., determining the minimum amount of SO_2 necessary to reduce the hexavalent chromium to the trivalent state.

Cline, J. E.; et al.

ANALYTICAL TECHNIQUES FOR THE IN SITU QUANTIFICATION OF LOW-LEVEL WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 387-83, March 1985.

A direct-assay technique quantitatively assays and characterizes the nuclides (including all 10 CFR 61, Table I and Table II nuclides) present in bulk radioactive wastes. Materials analyzed can include resins and sludges in transfer lines, tanks and liners, barreled oily wastes and DAW, and components stored in fuel pools. The methodology applies to a range of samples from high-activity resins and control-rod blades to slightly contaminated DAW. The system, based on advanced gamma-ray spectroscopy techniques, combines scanning with sample analysis results and correlation methodology to give a complete waste analysis that allows efficient, accurate, and cost-effective classification for packaging, shipment, and burial. The methodology can (1) improve accuracy by averaging over an entire container rather than depending on a single small sample from the usually inhomogeneous waste, (2) reduce accumulated man-rem exposure where highly radioactive wastes must be sampled and analyzed, (3) allow a more knowledgable and cost-effective choice of shipping container and cask, and (4) reduce burial costs by allowing less conservative estimates of total curies shipped in each container.

Coia, M. F.; Corbin, M. H.

APPLYING AN INNOVATIVE APPROACH TO FIELD INVESTIGATIONS AT A REMEDIAL ACTION SITE
Roy F. Weston, Inc., circa 1984.

Typical field investigation programs have utilized soil borings and groundwater monitoring wells to characterize contamination at hazardous waste sites. This paper describes an approach that can be applied at a hazardous waste site where known groundwater contamination exists and remedial action is necessary to mitiagate the environmental concerns. The sampling program is conducted to locate, as accurately as possible, the position, extent, and depth of contaminant source areas and to identify the potential contaminants present, as well as the potential extent of contaminant migration in the soil and groundwater. These sampling procedures utilize the maximum number of backhoe trench excavations (to locate the apparent boundary of contaminant source areas and obtain composite soil samples along a prescribed coordinate grid system) and field-implemented analytical techniques (to screen soil samples and eliminate those with little or no contamination). Laboratory analytical procedures are used to characterize the waste constituents found in the source areas and contaminated soils and to provide the necessary level of quality assurance.

Cole, L. W.; et al.

URANIUM INCINERATION
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. L1 to L13, March 1985.

Aerojet Heavy Metals Company (AHMC) operates two incinerators to convert uranium metal to uranium oxide in order to comply with the appropriate Department of Transportation and burial-site requirements for shipping a pyrophoric material. This paper will detail the construction, operation, and monitoring regulatory considerations for our uranium incinerators. The actual combusion chamber is a 55-gal drum submersed in a water bath for cooling, with a feeding and contaminant control hood connected to a ventilation system. Ventilation consists of ambient air for cooling of the combustion air stream, a prefilter, a HEPA filter, a stack, and associated monitoring equipment. The incinerators have been modified to reflect experience gained over several years of operation for increased productivity and safety. Approximately 2000 lb (909 kg) of uranium oxide have been generated and successfully shipped to waste burial sites. Radiological health problems have been minimal. Recent efforts have been directed at improved packaging of the oxide to meet criteria at the Barnwell, South Carolina, burial site for disposal of nondispersible waste. A risk analysis completed in 1984 indicates that transportation is the largest risk.

Colombo, P.; Kalb, P. D.; Fuhrmann, M.

WASTE FORM DEVELOPMENT PROGRAM ANNUAL REPORT OCTOBER 1982—SEPTEMBER 1983
BNL-51756, Brookhaven National Laboratory, 1983.

The primary focus of this work is the investigation of new solidification agents which will provide improved immobilization of LLRW in an efficient, cost-effective manner. A working set of preliminary waste form evaluation criteria which could impact on the movement of radionuclides in the disposal environment was developed. The selection of potential solidification agents for further investigation is described. Two thermoplastic materials, low-density polyethylene and a modified sulfur cement, were chosen as primary candidates for further study. Three waste types were selected for solidification process development and waste-form property evaluation studies which represent both "new" volume reduction wastes (dried evaporator concentrates and incinerator ash) and current "problem" wastes (ion-exchange resins). Waste loadings of 60 wt % Na_2SO_4, 25 wt % H_3BO_3, 25 wt % incinerator ash, and 50 wt % dry ion-exchange resin were achieved using low-density polyethylene as a matrix material. Samples incorporating 65 wt % Na_2SO_4, 40 wt % H_3BO_3, 20 wt % incinerator ash, and 40 wt % dry ion-exchange resin were successfully solidified in modified sulfur cement.

Colorado State University

MANAGEMENT OF URANIUM MILL TAILINGS, LOW-LEVEL WASTE, AND HAZARDOUS WASTE - VOLUME I
Colorado State University, Geotechnical Engineering Program, February 1985.

The Seventh Symposium, held at Colorado State University, Ft. Collins, Colorado, focused on the reclamation of waste disposal areas. The papers document the technology development that has taken place and define the current state of the art:

1. Regulations and Public Concerns - 6 papers,
2. Low-Level Waste - 6 papers, and
3. Uranium Mill Tailings Remedial Action Project (UMTRAP) - 14 papers.

Colorado State University

MANAGMENT OF URANIUM MILL TAILINGS, LOW-LEVEL WASTE, AND HAZARDOUS WASTE - VOLUME II
Colorado State University, Geotechnical Engineering Program, Februrary 1985.

The Seventh Symposium, held at Colorado State Univeristy in Ft. Collins, Colorado, focused on the reclamation of waste disposal areas. The papers document the technology development that has taken place and define the current state of the art:

1. Covers Long-Term Stability - 7 papers,
2. Hydraulic Properties of Tailings - 4 papers,
3. Contaminant Migration, Seepage and Groundwater - 11 papers, and
4. Case Histories - 12 papers.

Colvin, C. M.; Roberts, R. C.; and Williams, M. K.

SUMMARY OF THE ULTRAFILTRATION, REVERSE OSMOSIS, AND ADSORBENTS PROJECT
MLM-3033, Monsanto Research Corporation, January 1983.

The design for a medium-size [40-gal/min (150-L/min)] ultrafiltration (UF) membrane unit includes a schematic diagram, capital and operating costs, a list and discussion of the radioisotopes tested and the results achieved, operating parameters, and characteristics of the available membrane configurations. The plant design for a reverse osmosis (RO) membrane unit includes a conceptual diagram, specifications for a unit producing 40 gal/min (150 L/min) of permeated product, a list of radioisotopes tested on RO units and the rejections achieved, a discussion of the principle of RO, a discussion of the upper limits of cation and anion concentrations (there are no lower limits), a discussion of membrane configurations and porosities, a discussion of factors affecting membranes, a section on calculating the membrane area needed for a particular application, and capital and operating cost calculations. The design for an ion-exchange pilot plant includes a schematic diagram; flow, resin, and column specifications; impurity limits; and operating and capital costs. A short theoretical discussion and process description are also included. The design retains flexibility so that application to a specific stream can be determined.

Cooley, C. R.; Clark, D. E.

TREATMENT TECHNOLOGIES FOR NON-HIGH-LEVEL WASTES (U.S.A.)
HEDL-SA-851, Hanford Engineering Development Laboratory, June 1976.

Non-high-level waste arising from operations at nuclear reactors, fuel fabrication facilities, and reprocessing facilities can be treated using one of several technical alternatives prior to storage. Each alternative and the associated experience and status of development are summarized. The technology for treating non-high-level wastes is generally available for industrial use. Improved techniques applicable to the commercial nuclear fuel cycle are being developed and demonstrated to reduce the volume of waste and to immobilize it for storage.

Cooley, L. R.; McCampbell, M. R.; Thompson, J. D.

CURRENT PRACTICE OF INCINERATION OF LOW-LEVEL INSTITUTIONAL RADIOACTIVE WASTE
EGG-2076, EG&G Idaho, Inc., February 1981.

During 1979, 142 medical and academic institutions were surveyed to assess the current practice of incineration of low-level radioactive waste. This was one activity carried out by the University of Maryland as part of a contract with EG&G Idaho, Inc., to site a radioactive waste incineration system. Of those surveyed, 46 (approximately 32%) were presently incinerating some type of radioactive waste. All were using conrolled-air, multistage incinerators. Incinerators were most often used to burn animal carcasses and other biological wastes (96%). The average size unit had a capacity of 113 kg/h. Disposal of liquid scintillation vials posed special problems; eight institutions incinerated full scintillation vials, and five incinerated scintillation fluids in bulk form. Most institutions (87%) used the incinerator to dispose of other wastes in addition to radioactive wastes. About half (20) of the institutions incinerating radioactive wastes reported shortcomings in their incineration process. Frequently cited reasons for incinerating wastes were: (1) a lower cost as compared with shipping for commercial shallow-land burial, (2) volume reduction, (3) convenience, and (4) closure of existing disposal sites.

Cooper, W. R.; Sankey, C. A.

WIPP: CONSTRUCTION AND PROGRESS ON A SUCCESSFUL NUCLEAR WASTE REPOSITORY
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 71-73, March 1985.

The Department of Energy is constructing the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico. The facility will retrievably store transuranic waste from defense activities of the United States and conduct experiments with defense high-level waste which will be retrieved at the end of the experiments. This paper describes the progress and the present status of activities at WIPP.

Copeland, L. G.

SUCCESSFUL REMEDIAL ACTION AT A HAZARDOUS WASTE SITE
The Weston Way, Vol. 9, No. 2, Fall 1983.

In May 1983, Weston completed the largest single hazardous waste excavation and disposal operation ever funded by the U.S. Army. The project involved the engineering and excavation of 62,000 tons (56,000 t) of organic-laden soils, sludges, and liquids from two sites located on the Anniston Army Depot in Anniston, Alabama.

This $4.6 million project was funded by the Department of Defense as a part of its ongoing program to establish environmentally sound operating practices in its facilities located throughout the United States.

Couture, J.

STATUS OF THE FRENCH REPROCESSING INDUSTRY
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 33-45, August 26-29, 1984.

Reprocessing of light water reactor fuel is an industrially demonstrated activity as attested by the results achieved at the La Hague plant, both for production performance and for safety. A large expansion project is under way at La Hague to increase its reprocessing capacity to 1600 metric tons of LWR fuel per year; it draws upon the know-how and operating experience acquired at that plant. High-level waste management using proven vitrification technology will provide a product suitable for final disposal. Other reprocessing plants are under design or construction elsewhere in Europe. The fuel cycle will be closed through utilization of plutonium either in breeder reactors or in light water reactors in the form of mixed oxide fuel. Figures concerning the impact of reprocessing on the cost of the nuclear kilowatt hour in France will be given.

Cramer, E. N. (Technical Program Chairman)

Transactions of the American Nuclear Society
Vol. 41, pp. 100-3, June 1982.

The following articles are included in this volume:

1. Nonradioactive Zeolite Vitrification Process Demonstration Results,
2. Electrolytic Decontamination of Torus Steel for Release as Salvage, and
3. Decontamination of Uranium-Contaminated Iron by Smelting.

Crandall, J. L.

TREATMENT AND CONDITIONING OF WATERS FROM U.S. NUCLEAR FUELS REPROCESSING PLANTS
DP-MS--83-22, E. I. du Pont de Nemours & Co., May 1983.

The liquid high-level wastes at U.S. facilities at Hanford and Savannah River have, for nearly 40 years, been conditioned for storage by adding NaOH, a process which precipitates most of the radionuclides except Cs in an insoluble sludge. Mechanical separation of this sludge, coupled with decontamination of the supernate by ion exchange and/or precipitation, gives a waste concentrate for immobilization. The Defense Waste Processing Facility at Savannah River is under construction to immobilize this concentrate in borosilicate glass. Idaho is just placing a new calciner in operation to treat their acid wastes directly. Techniques have also been developed to remove Cs, Sr, and noble metals from the liquid wastes for defense purposes and commercial uses. Except at West Valley, New York, the U.S. technique to date has been to dissolve the fuel clad rather than to shear-leach it. However, because shear-leach is the expected future process, the United States has also developed techniques both for immobilizing leached clad in concrete and for decontaminating it by melting. With regard to gaseous waste, the current U.S. reprocessing plants treat their off-gas mainly to remove iodine and particulates.

Croff, A. G.; Blomeke, J. O.; Finney, B. C.

ACTINIDE PARTITIONING-TRANSMUTATION PROGRAM FINAL REPORT.
I. OVERALL ASESSMENT
ORNL-5566, Oak Ridge National Laboratory, June 1980.

This report is concerned with an overall assessment of the feasibility of and incentives for partitioning long-lived nuclides from fuel reprocessing and fuel refabrication plant radioactive wastes and transmuting them to shorter-lived or stable nuclides by neutron irradiation. The principal class of nuclides considered is the actinides, although a brief analysis is given of the partitioning and transmutation (P-T) of ^{99}Tc and ^{129}I. Three major conclusions concerning technical feasibility can be drawn from the assessment: (1) actinide P-T is feasible, subject to the acceptability of fuels containing recycle actinides; (2) technetium P-T is feasible if satisfactory partitioning processes can be developed and satisfactory fuels identified (no studies have been made in this area); and (3) iodine P-T is marginally feasible at best because of the low transmutation rates, the high volatility, and the corrosiveness of iodine and iodine compounds. It was concluded, on the basis of a very conservative repository risk analysis, that there are no safety or cost incentives for actinide P-T. Incentives for technetium and iodine P-T exist only if extremely conservative long-term risk analyses are used.

DaCosta, D.; Abrams, R.

RADWASTE INCINERATOR WET SCRUBBER CORROSION TESTS AND BLOWDOWN ELIMINATION
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, p. C1, March 21, 1985.

Radwaste incinerators that reduce the volume of nuclear power reactor wastes utilize wet scrubbing systems to remove particulates and neutralize acid gases present in the incinerator effluent. Koch Process Systems (KPS) has developed a radwaste incinerator using the controlled-air incineration process in place at Los Alamos National Laboratory. During the development program, KPS identified two areas of concern with the wet scrubbing systems when processing power reactor wastes: (1) because power reactor waste processing equipment should have metallic process boundaries per Regulatory Guide 1.143, corrosion-resistant materials suitable for the harsh chemical environment must be identified for use; and (2) scrubber blowdown would adversely affect the achievable volume reduction factors unless it could be internally eliminated within the incineration system. KPS conducted two research and development programs to resolve these areas of concern. The KPS incinerator wet scrubbing system design is based on the program results.

Dam, A. S.; Bradley, M. J.

A COMPARISON BETWEEN MOBILE VR SERVICES AND CENTRAL VR SERVICE FACILTY FOR DRY ACTIVE WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 539-42, March 1985.

Low-level radioactive dry wastes can be volume-reduced using either mobile or central facilities with super-compactors, or incinerators, or both. This paper compares the technical, operational, and economic factors for mobile versus central facilities. Analyses indicated that customer costs, in addition to the service vendors fee, are a significant factor in the evalution of mobile services. The most attractive option is a central facility offering both incineration and super-compaction.

Dam, A. S.; Bradley, M. J.; Bowles, C. R.; Brandt, R.

LOW-LEVEL VOLUME REDUCTION SERVICES FACILITY
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 187-89, March 1985.

The Babcock & Wilcox Company is renovating the shutdown fuel fabrication faciliites in Parks Township, Pennsylvania, and installing equipment to operate a Volume Reduction Services Facility for low-level radioactive waste. This facility, outfitted with both an incinerator and a super-compactor, will have the capability to handle dry solids, contaminated oils, liquid scintillation vials, and biological waste and is to be the first commercial facility in the United States to utilize both incineration and super-compaction for the volume reduction of low-level radioactive waste. This paper deals with the planned operations for the Babcock & Wilcox Reduction Services Facility in Park Township, Pennsylvania.

Dameron, H. J.

SOLID WASTE MINIMIZATION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 405-8, March 1985.

As more nuclear stations come on-line, Duke is faced with increasing solid waste volumes and increasing burial site rates. In an attempt to reduce these volumes, studies were conducted to quantify and to address specific waste forms. The schemes used include administrative controls, equipment purchase and building modification, and requests for regulatory exemptions.

Davis, M. S.

THE IMPACT OF LWR DECONTAMINATIONS ON SOLIDIFICATION, WASTE DISPOSAL AND ASSOCIATED OCCUPATIONAL EXPOSURE - ANNUAL REPORT NUREG/CR-3444, BNL-NUREG-51699, Brookhaven National Laboratory, August 1983.

This report describes generic and specific aspects of hard and soft chemical decontaminations and considers the radiation and thermal stability of the reagents involved. Disposal options for LWR decontamination wastes are discussed. Studies indicating the potential impact of these wastes on a shallow-land burial ability to retain radionuclides are summarized. Processes being considered for the management of spent ion-exchange resins are reviewed. Problems associated with the state of the art of incineration, pyrolysis, wet-air oxidation, acid digestion, and chemical digestion are evaluated. The solidification and disposal of decontamination wastes are considered with respect to criteria given in the Licensing Rule for Land Disposal of Radioactive Waste, 10 CFR 61. These are evaluated with respect to possible solidification in cement, bitumen, and plastics. The various options in mixing decontamination wastes with normal LWR resin waste are discussed with respect to their impacts on occupational exposure.

Deacon, L. E.

CHROMIUM RECOVERY FROM RCW-PRODUCED SLUDGES WITH HIGH IRON CONTENT
GAT-T-2519, Goodyear Atomic Corporation, March 1976.

Previous work at Portsmouth has proved the efficacy of a calcination-water leaching technique to recover chromium from RCW-produced sludges in which the hexavalent chromium was chemically reduced with sulfur dioxide and subsequently precipitated with lime.

A preliminary laboratory investigation has been completed to determine the effects of iron on chromium recovery from recirculating cooling water sludges in which the hexavalent chromium has been reduced with ferrous sulfate. Recovery of greater than 80% has been realized; however, difficulty was encountered with "clinkers" in the calcination residue, which may make the recovery process economically unjustifiable.

Deacon, L. E.

CHROMIUM RECOVERY FROM SLUDGE PRODUCED AT THE X-616 LIQUID EFFLUENT CONTROL FACILITY
GAT-T-2969, Rev. 1, Goodyear Atomic Corporation, May 1980.

Current EPA regulations require the removal of hexavalent from liquid effluents to a concentration not exceeding 0.05 ppm (0.05 mg/L) prior to discharge. At GAT, the chromate corrosion inhibitor present in the recirculating cooling water (RCW) blowdown is removed, prior to discharge to the Scioto River, at the X-616 Liquid Effluent Treatment Facility. The resulting chromium hydroxide-containing sludge is stored in unlined earthen lagoons. Resource Conservation and Recovery Act (RCRA) regulations are directed toward recovery and recycling of materials, e.g., chromium recovery for reuse in the RCW system. Several techniques have been investigated at GAT for chromium recovery from RCW blowdown. The most effective recovery scheme was found to be one in which insoluble chromium hydroxide was oxidized to water-soluble sodium chromate by mixing the X-616 sludge with soda ash and calcining the mixture. The chromium was then removed from the insoluble residue by a water leach. Pilot-plant studies have been completed which indicate average recovery efficiencies of approximately 96 wt % of available chromium in the sludge. However, the residue still contains sufficient leachable chromium that it is considered hazardous.

Deacon, L. E.

ENCAPSULATION OF HAZARDOUS SLUDGES IN CONCRETE FOR LANDFILL
GAT-T-3158, Goodyear Atomic Corporation, May 1982.

The Federal EPA has promulgated hazardous waste guidelines which assign "cradle to grave" responsibilities to any industry generating a hazardous waste. During characterization of plant-site sludges, the X-616 chromate removal sludge was found to exceed the leachable chromium limit. The X-700 degreaser sludge, originating from a listed nonspecific source, was also classified as hazardous. Parameters were established for concrete encapsulation of the two sludges. EP leach tests showed that the X-616 sludge fixation in concrete was successful in reducing chromium below the defined hazard limit in the extract. Extracts from leach tests of the X-700 degreaser sludge contained trichloroethylene, indicating failure of the concrete encapsulation to retain this solvent. However, neither sludge encapsulation method is believed to provide a viable treatment for sludge disposal. The increased storage volume which would be required for encapsulated X-616 sludge indicates that some form of chromium recovery and recycle should be considered. The X-700 degreaser sludge is generated in low annual volumes [300 gal (1100 L)]. It would be more feasible to store degreaser sludge in steel drums for future incineration, followed by concrete encapsulation.

Deacon, L. E.

POLYELECTROLYTES FOR USE AS COAGULATION AIDS AT THE X-616 LIQUID EFFLUENT CONTROL FACILITY
GAT-T-2415, Goodyear Atomic Corporation, October 1975.

The reduction-precipitation process used in the X-616 Liquid Effluent Control Facility produces a metal hydroxide sludge, which is both difficult and time-consuming to settle. A coagulant aid added to the clarifier will increase the settling rates and increase the stability of the sludge.

Comparison tests have shown that anionic polyelectrolytes used as coagulant aids can reduce the settling time by as much as 80% while substantially decreasing the amount of suspended solids in the discharged water.

De Buzonniere, A.; Raibaud, J.; Augustin, X.

SETH 200 - A NEW MOBILE UNIT FOR SPENT ION-EXCHANGE RESINS EMBEDDING IN POLYMERS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 163-64, March 1985.

The CEA embedding process for low- and medium-activity waste in thermosetting resins (polyester or epoxy) has been used industrially. Recent developments (elimination of chemical pretreatment, thanks to a new epoxy formulation and technological breakthroughs in the operating techniques) have greatly increased the potential of the process. Technicatome's industrial experience has resulted in the design of an easily operated mobile unit which is very competitive, particularly for spent resin processing.

Defense Low-Level Radioactive Waste Management Program

LONG-RANGE PLAN FOR DEFENSE PROGRAM LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT PROGRAM
U.S. Department of Energy, January 1985.

The Defense Low-Level Waste Management Program is to provide assurance that DOE sites have the necessary technology for managing defense low-level waste. The need to modify low-level waste practices to conform to DOE Order 5820.2, stabilize and close filled low-level waste disposal sites, and provide for alternative methods of disposal for special wastes may necessitate the development and implementation of new technologies and practices. The Program provides a central point of focus and expertise to assess the long-term technology needs of the Department's low-level waste management facilities and to design and implement technology development or demonstration projects to meet these needs. New techniques and measures are being developed in many areas, as well as additional measures and techniques to improve past disposal site performance. Documentation and support are also provided. The program efforts culminate in the implementation of technology by facility operators as part of each facility's standard practices.

Dejonghe, P.; Van de Voorde, N.; Bonne, A.

OPTIMIZATION STUDIES CONCERNING VOLUME REDUCTION AND CONDITIONING OF RADIOACTIVE WASTE IN VIEW OF STORAGE AND DISPOSAL
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 2, pp. 139-51, August 26–29, 1984.

Volume reduction of low level and medium level wastes and end-product is a major challenge in the management of radioactive wastes. Comments will be given on recent achievements in the treatment of non-high-level liquid and solid wastes from power reactors and low-level, plutonium-contaminated wastes. The latter results can contribute to an overall optimization of a radioactive waste management scheme, including the final disposal of the conditioned materials.

Some detailed results will be given concerning volume reduction, decontamination factors, degree of immobilization of the contained radioelements, and cost considerations.

Deltete, C. P.

DRY ACTIVE WASTE: VOLUMES, SOURCES, AND COMPOSITION
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. E1 to E16, March 21, 1985.

The objective of this paper is to summarize the volumes, sources, and compositions of typical nuclear-utility dry active waste (DAW), thereby establishing a common reference point of pertinent waste parameters for later discussions of specific VR technologies and systems. Much of the data used to develop this paper was compiled by the author under a research project sponsored by the Electric Power Research Institute (EPRI). The results of the project were published in January 1984 as the three-volume EPRI Report No. NP-3370.

This paper is not intended to rehash the technical attributes, licensability, or economics of radioactive waste volume reduction (VR) per se. Nor is the paper intended to specifically endorse incineration or any of the other VR methods presently available and being marketed to the nuclear industry. Several other papers will address these issues, and they must stand on their own technical and economic merits. It is the author's opinion however, that a thorough understanding of the anticipated waste source material is an absolute necessity to the proper evaluation and selection of any VR system.

Deltete, C. P.; Daloisio, G. S.; Wilson, R. B.

IDENTIFICATION OF RADWASTE SOURCES AND REDUCTIONS TECHNIQUES,
VOLUME 1: IMPLEMENTATION HANDBOOK
EPRI NP-3370, Gilbert Associates, Inc., January 1984.

The Electric Power Research Institute (EPRI) commissioned an operations-related project (RP1557-3) in late 1981 to develop a methodology which can be used by utility operations managers in evaluating the radwaste generation rates at their nuclear stations, and to help them identify successful volume minimization techniques which can be applied to reduce these radwaste sources. The result of the project is a three-volume report comprising radwaste-related information from over two-thirds of the operating nuclear plants in the country as of December 31, 1981. Volume 1 is intended to serve primarily as a "handbook" and includes: (1) the major conclusions obtained throughout the report; (2) a method to evaluate a plant's waste management program effectiveness in minimizing radwaste generation in comparison to industry performance, and (3) radwaste volume-minimization techniques succesfully used at operational nuclear stations. Volume 2 describes the project's technical approach and provides detailed evaluations of the waste source/characteristics data gathered during the project, while Volume 3 provides the entire computerized data base of plant waste sources and characteristics used in the project.

Deltete, C. P.; Daloisio, G. S.; Wilson, R. B.

IDENTIFICATION OF RADWASTE SOURCES AND REDUCTIONS TECHNIQUES,
VOLUME 2: PROJECT EVALUATION
EPRI NP-3370, Gilbert Associates, Inc., January 1984.

The Electric Power Research Institute (EPRI) commissioned an operations-related project (RP1557-3) in late 1981 to develop a methodology which can be used by utility operations managers in evaluating the radwaste generation rates at their nuclear stations and to help them identify successful volume minimization techniques which can be applied to reduce these radwaste sources. The result of the project is a three-volume report comprising radwaste-related information from over two-thirds of the operating nuclear plants in the country as of December 31, 1981. Volume 1 is intended to serve primarily as a "handbook" and includes: (1) the major conclusions obtained throughout the report, (2) a method to evaluate a plant's waste management program effectiveness in minimizing radwaste generation in comparison to industrial performance, and (3) radwaste volume minimization techniques succesfully used at operational nuclear stations. Volume 2 describes the project's technical approach and provides detailed evaluations of the waste source/characteristics data gathered during the project, while Volume 3 provides the entire computerized data base of plant waste sources and characteristics used in the project.

Deltete, C. P.; Daloisio, G. S.; Wilson, R. B.

IDENTIFICATION OF RADWASTE SOURCES AND REDUCTIONS TECHNIQUES,
VOLUME 3: DATA BASE
EPRI NP-3370, Gilbert Associates, Inc., January 1984.

The Electric Power Research Institute (EPRI) commissioned an operations-related project (RP1557-3) in late 1981 to develop a methodology which can be used by utility operations managers in evaluating the radwaste generation rates at their nuclear stations and to help them identify successful volume minimization techniques which can be applied to reduce these radwaste sources. The result of the project is a three-volume report comprising radwaste-related information from over two-thirds of the operating nuclear plants in the country as of December 31, 1981. Volume 1 is intended to serve primarily as a "handbook" and includes: (1) the major conclusions obtained throughout the report, (2) a method to evaluate a plant's waste management program effectiveness in minimizing radwaste generation in comparison to industrial performance, and (3) radwaste volume minimization techniques succesfully used at operational nuclear stations. Volume 2 describes the project's technical approach and provides detailed evaluations of the waste source/characteristics data gathered during the project, while Volume 3 provides the entire computerized data base of plant waste sources and characteristics used in the project.

Department of Energy

FINAL ENVIRONMENTAL IMPACT STATEMENT - INCINERATION FACILITY FOR RADIOACTIVELY CONTAMINATED PCBs AND OTHER WASTES
DOE/EIS-0084, U.S. Department of Energy, June 1982.

The statement assesses the environmental impacts associated with the construction of an incineration facility and related support facilities for the disposal of hazardous organic waste materials (including PCBs) which are contaminated with trace quantities of low-assay enriched uranium. The proposed action includes the incineration facility at Oak Ridge, Tennessee, and storage, packaging, and shipping facilities at the Gaseous Diffusion Plants in Paducah, Kentucky, and Portsmouth, Ohio; hazardous organic wastes from these plants and from the Y-12 Plant and Oak Ridge National Laboratory would be shipped to the proposed incineration facility. Impacts assessed include the effects of the project on air and water quality, socioeconomic conditions, public and occupational health and safety, and ecology. Additionally, the statement presents an assessment of the potential impacts from accidents at the incineration facility or during transportation of the waste materials to the facility.

Department of Energy

LOW-LEVEL RADIOACTIVE WASTE POLICY ACT REPORT
DOE/NE-0015, U.S. Department of Energy, 1980.

This report does the following:

1. Defines the disposal capacity needed for present and future LLRW on a regional basis.
2. Defines the status of all commercial low-level radioactive waste disposal sites; evaluates the license status of each such site, the state of operation of each site, including operating history, and the adequacy of the disposal technology employed at each site to contain low-level radioactive wastes for their hazardous lifetimes; and presents such recommendations as the Secretary considers appropriate to ensure the protection of public health and safety from wastes transported to such sites.
3. Evaluates the transportation requirements on a regional basis and in comparison with present practices for the shipment of low-level radioactive wastes (including an inventory of the types and quantities of low-level radioactive wastes) and evaluates shipment requirements for each type of waste and the ability of generators, shippers, and carriers to meet such requirements.
4. Evaluates the capability of the low-level radioactive waste disposal facilities owned and operated by the DOE to provide interim storage for commercially generated low-level wastes and estimates the costs associated with such interim storage.

Detilleux, E. J.; Tonon, P.

MANAGEMENT OF NUCLEAR SPENT FUEL AND RADIOACTIVE WASTE IN BELGIUM
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 3-13, August 26–29, 1984.

Besides the setting up of nuclear power plants which, from 1986 onwards, will generate 65% of her electricity, Belgium has during the last 30 years developed important activities aiming at a sound management of spent nuclear fuels and radioactive wastes. In recent years, both the authorities and industry have made decisions and taken actions aimed at the promotion of spent fuel reprocessing, the recycling of plutonium and the long-term management of the wastes. The present paper describes the institutional, technical, and financial aspects of these decisions and measures.

Diaz, N. J. (Technical Program Chairman)

Transactions of the American Nuclear Society
Vol. 38, p. 199, June 1981.

This volume includes the following article: "Design and Operation of a Prototype Incinerator for Beta-Gamma Waste."

Dietz, S.; Emmet, M.; DeGaetano, R.; Tuttle, D; Vincent, C.

NATIONAL SURVEY OF HAZARDOUS WASTE GENERATORS AND TREATMENT, STORAGE, AND DISPOSAL FACILITIES REGULATED UNDER RCRA IN 1981
EPA-530, Westat, Inc., April 1984.

This report summarizes the findings of an extensive national survey of hazardous waste generators and treatment, storage, and disposal facilities regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976, as amended. The survey, conducted by mail during the fall of 1982 and the spring of 1983, was administered by Westat under the sponsorship and direction of the U.S. Environmental Protection Agency's (EPA) Office of Solid Waste (OSW).

The survey produced a statistically weighted data base containing more than 6000 statistical data elements describing hazardous waste generation and management activities in 1981, the study year. The findings presented in this report are drawn from only a portion of these data, but they are intended to provide a broad overview of the nature and scope of the populations of regulated hazardous waste generators and treatment, storage, and disposal facilities and of the hazardous wastes they generate and manage.

Dillman, C. W.; Rodriguez, L. F.; Taylor, G. E.; Weech, M. E.

DESIGN OF A MODULAR RADWASTE FACILITY
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 239-43, March 1985.

This paper describes the design of a modular radwaste volume reduction and solidification unit based on the AZTECH process developed and patented by the General Electric Company.

Several years ago, General Electric recognized the need for an improved encapsulation medium for low-level radioactive waste. The desired characteristics of the improved media were: volume reduction capability, compatibility with all common waste forms, high availability, safety, and ease of operation.

In response to the identified need, General Electric undertook the bench-scale and pilot-plant testing. This effort led to the selection of polyester as the preferred encapsulation medium. Polyester offered all the desired advantages, plus superior leach resistance in comparison to the commonly used encapsulation media. Enhanced leach resistance was considered important as protection against the potential that federal regulations will be made more stringent or that the new state and regional compacts will require enhanced properties for material accepted at the burial sites.

DiSalvo, R.

LICENSING EXPERIENCE FOR A CENTRALIZED LLW INCINERATION FACILITY
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. DD1 to DD11, March 1985.

Battelle's Columbus Laboratories has applied to the U.S. Nuclear Regulatory Commission for authorization to incinerate low-level radioactive wastes. The proposed incinerator is the focal point of a research and demonstration program investigating the technical and economic viabilty of central site incineration. Earlier progress on this program was presented in a previous technical conference. This paper describes recent experience toward receiving regulatory authorization.

Dodge, R. L.; Edwards, C. W.; Wilson, B.

LICENSING REQUIREMENTS FOR BACKFIT INCINERATORS AT COMMERCIAL NUCLEAR POWER PLANTS
ECG-M-19383, EG&G Idaho, Inc., 1984.

This paper, and the project it reports on, examines the licensing requirements for backfit incinerators at operating power plants. Analysis was made of incinerating low-level dry radioactive waste in a backfit incinerator at an existing power plant. The operation of the incinerator has been studied from viewpoints of operator safety, consequence of system failures including "worst case" scenarios, and radiological impact for normal and upset conditions. Analysis showed that releases under all normal operating or upset conditions are an extremely small fraction of the applicable limits. Nuclear Regulatory Commission review concluded that the document produced as a result of this project was useful as a design guide and of value in licensing backfit incinerators.

Dukes, E. K.

THE SAVANNAH RIVER PLANT ENVIRONMENT
DP-1642, E. I. du Pont de Nemours & Co., March 1984.

This report is a description of the geological, hydrological, meteorological, and biological characteristics of the Savannah River Plant site and is intended as a source of information for those interested in environmental research at the site. It is also intended as a reference for those preparing reports about aspects of operation of production and support facilities at the Savannah River Plant.

The SRP site has the most comprehensive environmental monitoring program of any site in the United States. The program includes radiological and nonradiological monitoring at and in the vicinity of the site. Over the years, the results of this program have shown that the impact of SRP operations on public health is insignificant.

Dworschak, H.; Hunt, B. A.; Mousty, F.

STUDY OF WASTE MANAGEMENT STRATEGIES WHICH MINIMIZE THE LONG-TERM RISK: WASTE STREAMS MERGING
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 2, pp. 152-62, August 26-29, 1984.

For a coherent approach in long-term waste management, a potential resolution for MAW management is considered, involving the merging of selected medium-level liquid waste streams with HAW. Such a concept can be extended in its application by incorporating either separately or in waste components the possibility for isolation and separate treatment of neptunium and its precursors. These waste management alternatives are being considered for incorporation into the activity program of the "PETRA" project currently under way at the JRC Ispra.

Ecolaire Environmental Control Products, Inc.

INSTITUTIONAL-INDUSTRIAL-MUNICIPAL INCINERATION AND ENERGY RECOVERY SYSTEMS
Promotional Brochure, Ecolaire Environmental Control Products, Inc., 1985.

All Ecolaire ECP Incinerators are based on the controlled-air incinerator principle refined, if not indeed developed, by Ecolaire ECP over the last 15 years. This principle involves two chambers of combustion: a lower ignition chamber where the waste is actually burned in a starved-air environment, and an upper chamber where the combustion gases from the lower chamber are burned at extremely high temperature and where "excess air" conditions are maintained.

The advantage of this combustion technology is that a wide range of waste materials can be burned without the need for additonal air pollution control devices such as scrubbers, baghouses, and precipitators. The exhausted gases may be fed to a heat recovery boiler for energy conservation if desired.

EG&G Idaho, Inc.

THE 1983 STATE-BY-STATE ASSESSMENT OF LOW-LEVEL RADIOACTIVE WASTES SHIPPED TO COMMERCIAL DISPOSAL SITES
DOE/LLW-39T, Conference of Radiation Control Program Directors, December 1984.

In the past, researchers who have studied the quantities and radioactivity levels of low-level wastes generated in the United States typically combined the entire waste volume of the country. To assist states in extrapolating more accurate estimates of generation rates, this report separated the waste into four broad categories: (1) institutional, (2) industrial, (3) commercial reactor, and (4) government. In 1983, nonreactor waste is better defined by separating categories into (1) academic, (2) medical, (3) government, and (4) industrial. For maximum utility by state policymakers, estimated volume amounts for each of these categories were tabulated on a state-by-state basis. Results from generator surveys and feedback from state officials continue to refine our understanding of the sources of low-level radioactive waste and enhance the quality of generation data. Sources included NRC records on power-plant waste shipments, the DOE Solid Waste Information Management Systems for the portion of defense wastes shipped to commercial sites, and national studies on institutional waste generation prepared by the University of Maryland at Baltimore. The industrial data were based on the state's population and the radioactive material licensees in the state.

Ensminger, D. A.; Kaplan, M. F.

CRITERIA DEFINITION FOR LLRW SOLIDIFICATION AND CONTAINERIZATION
EPRI NP-3112, The Analytic Sciences Corporation, May 1983.

This report describes the methodology and results of a study performed by TASC for EPRI. The objective is to define minimum performance standards for LLRW solidification and containerization technologies and to assess the state of the art of those technologies. The major conclusion is that there is no compelling evidence indicating that current LLRW solidification and containerization technologies are inadequate to protect the public health and safety.

The technical approach to this study consists of choosing a set of parametersfor a reference burial site, modeling key dose pathways to man, and deriving necessary waste-form leach rates and container lifetimes from dose limits specified in draft 10 CFR Part 61. The work concludes that only four radionuclides out of the 25 buried in the site require treatment or control measures of any kind to limit their dose. Two of the nuclides (^{3}H and ^{14}C) are generated almost entirely by non-fuel-cycle facilities, and the remaining two (^{99}Tc and ^{129}I) can have their dose limited to required levels by the use of an advanced waste form or improved site management practices.

Environmental Information, Ltd.

INDUSTRIAL AND HAZARDOUS WASTE MANAGEMENT FIRMS - 1985
Environmental Information, Ltd., 1985.

This is a directory of industrial and hazardous waste management services available in the 48 states and the District of Columbia. The focus of the directory is commercial facilities where industrial and hazardous wastes are recycled, treated, stored, or disposed of. Within this scope, the directory includes 22 companies which offer reclamation, treatment, or detoxification on a mobile basis. The 1985 directory includes information on more than 400 facilities, more than 500 transportation services, and numerous other special services.

Part I, state sections, is organized to describe the services available in each state. Part II is an alphabetical master list of all the transporters included in the directory. Special services, Part III, can be used to help identify and locate companies which offer a particular waste management service.

Environmental Laboratory

GUIDE TO THE DISPOSAL OF CHEMICALLY STABILIZED AND SOLIDIFIED WASTE
SW-872, Environmental Laboratory, September 1982.

Stabilization/solidification of industrial waste is a pretreatment process that has been proposed to ensure safe disposal of wastes containing harmful materials. This manual examines the regulatory considerations, current and proposed technology, testing procedures and design of landfills, and other options involved in disposal systems using stabilization/solidification technology. A summary of each process is included.

Environmental Protection Agency

ENVIRONMENTAL EMERGENCY RESPONSE UNIT CAPABILITY
Environmental Protection Agency, April 1982.

The Environmental Emergency Response Unit (ERU) is the U.S. Environmental Protection Agency's hazardous material spill response and control organization for situations where the use of complex cleanup equipment and techniques is required. EERU is engaged in the shakedown and field demonstration of prototypical equipment and techniques that have been developed under the direction and sponsorship of EPA's Municipal Environmental Research Laboratory. The booklet describes the following equipment that is currently available: Acoustic Emission Monitoring Device, Carbon Adsorption Pilot Plant, Cyclic Colorimeter, Foak Dike System, Hazardous Material Detection Kit, Hazardous Material Identification Kit, Hazardous Materials Spill Warning System, Mobile Decontamination Station for Field Personnel, Mobile Field Office, Mobile Flocculation-Sedimentation System, Mobile Laboratory, Mobile Physical-Chemical Treatment Trailers, Mobile Stream Diversion System, Multipurpose Gelling Agent, and Pesticide Detection Apparatus. It also describes six types of equipment currently under development.

Environmental Protection Agency

ENVIRONMENTAL RESPONSE TEAM
Environmental Protection Agency, April 1984.

This booklet describes the Environmental Response Team (ERT), a group of 12 hazardous waste experts who provide multidisciplinary assistance to EPA's other hazardous waste response experts located in its ten regional offices. Together, they can bring to bear upon a problem nearly 130 years of technical experience in dealing with hazardous wastes.

Some of the primary functions team members are trained to perform include: chemical, biological, and physical treatment and monitoring techniques; control, restoration, disposal, and contingency planning during emergencies; installation, operation, and evaluation of instrumentation and field response systems; sampling and analysis of air, water, and soil; water pollution biology and toxicology; environmental radiation training; occupational health and safety, and computerized gas chromatography/mass spectrometry.

Environmental Protection Agency

FEDERAL REGISTER - HAZARDOUS WASTE AND CONSOLIDATED PERMIT REGULATIONS
Federal Register, Vol. 45, No. 96 , Book 2, pp. 33063-285, May 19, 1980.

The information presented here can be categorized as follows:

Part II - Hazardous Waste Management System
Part III - Identification and Listing of Hazardous Waste
Part IV - Proposal to Modify 40 CFR Part 261 - Hazardous Waste Lists
Part V - Standards Applicable to Generators of Hazardous Waste
Part VI - Standards Applicable to Transporters of Hazardous Waste
Part VII - Standards and Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
Part VIII - Proposal to Modify 40 CFR Part 265 - Subpart H - Financial Requirements
Part IX - Proposal to Modify 40 CFR Part 265 - Subpart R - Underground Injection

Environmental Protection Agency

PROCEEDINGS OF THE TENTH ANNUAL RESEARCH SYMPOSIUM AT FT. MITCHELL, KENTUCKY
EPA-600/9-84-007, JACA Corporation, April 1984.

The Tenth Annual Research Symposium on Land Disposal, Remedial Action, Incineration, and Treatment of Hazardous Waste was held in Fort Mitchell, Kentucky, on April 3-5, 1984. The purpose of the symposium was to present to persons concerned with hazardous waste management the latest significant findings of ongoing and recently completed research projects funded by the Municipal Environmental Research Laboratory's Solid and Hazardous Waste Research Divison and the Industrial Environmental Research Laboratory's Energy Pollution Control Division.

This volume is a compilation of speakers' papers and poster presenters' abstracts for Session A, Hazardous Waste Land Disposal. Areas covered are: (1) Remedial Action, (2) Pollutant Assessment, and (3) Pollution Control. Subjects include landfill design and operation, waste leaching and analyses, pollutant migration and control, waste modification, surface impoundments, technology assessments, remedial action techniques, and cost/economics.

This document covers hazardous waste land disposal only.

Environmental Protection Agency

PROJECT INFORMATION SHEETS FOR RELEASES CONTROL BRANCH RESEARCH PROGRAM
Environmental Protection Agency, November 1984.

Information sheets on the research, development, or demonstration projects listing the following information:

1. Contract/Cooperative Agreement Number
2. Title of Project
3. Contractor/Recipient
4. Project Director
5. Federal Cost
6. Task No. - Objective - PPA - Project
7. Project Officer
8. Description of Project
9. Results to date
10. Project Start and Completion Date

Environmental Protection Agency

SLURRY TRENCH CONSTRUCTION FOR POLLUTION MIGRATION CONTROL
EPA-540/2-84-001, Environmental Protection Agency, February 1984.

This report is intended to provide reviewers of remedial action plans with the necessary background material to evaluate the portions of the plan dealing with pollution migration control slurry walls. A discussion of the early development and use of slurry trench construction techniques, both in Europe and the United States, is given to acquaint the reader with the history of the technique. An in-depth description of the currently held theories regarding the functions of bentonite slurries and the various backfill materials is presented. Data on filter cake formation, slurry viscosity, thixotropy, as well as the effects of cement on the functioning of both slurry and backfill, are included. Failure mechanisms are also discussed. Typical slurry wall configurations are described along with the various other remedial measures appropriate for use in conjunction with slurry walls. After the discussion of the fundamentals of slurry wall, the procedures for planning, designing, constructing, monitoring, and maintaining a slurry wall are presented. The handbook concludes with a series of evaluation criteria that correspond to the stages of a slurry wall installation. A glossary of commonly used terms is also included.

Environmental Protection Agency Capsule Report

ACOUSTIC MONITORING TO DETERMINE THE INTEGRITY OF HAZARDOUS WASTE DAMS
EPA 625/2-79-024, Environmental Protection Agency, August 1979.

There are as many as 500,000 diked areas in the United States containing potentially hazardous wastes. This total includes small waste ponds at minor chemical manufacturing plants, as well as mile-square tailings lagoons at mines, smelters, and phosphoric acid plants.

Because the problem is extensive, involving thousands of small facilities, an inexpensive and simple technique for monitoring the stability of earthen dams was desired. It seemed unlikely that conventional methods of inspection, which require expensive instrumentation and trained geotechnical engineers, could meet the need. Under this impetus, a system-acoustic emission monitoring was developed based on the phenomenon that soils emit sounds under stress. The EPA's Oil and Hazardous Materials Spills Branch, in Edison, New Jersey, awarded a grant to Drexel University to develop an acoustic emission monitoring system to determine the stability of dams. The Drexel investigators found that the resulting signals, when properly amplified and quantified, can be a valuable guide in evaluating the stability of earthen dams.

EPA Municipal Wastewater and Spill Prevention Research Committee

EMERGENCY SPILLS RESEARCH STRATEGY 1980-1984
Environmental Protection Agency, June 1980.

The purpose of the emergency spills R&D program is to provide technical information to prevent the release of oil and hazardous substances to the environment and to mitigate the environmental effects of such a release. Specifically, the program concentrates on the development of technology and techniques for preventing, controlling, removing, and ultimately disposing of oil and hazardous substances released to the environment. It also provides an assessment of the ecological and health impacts from such a release, and technology and techniques for the restoration of the environment. The objective of the R&D performed under the monitoring systems and quality assurance program element is to provide specialized analytical support, overhead monitoring, chemical and biological laboratory field support, and quality assurance to the investigations of spills, for emergency support, as well as cleanup and enforcement activities. The program also defines techniques for the redevelopment and restoration of ecosystems that have been biologically damaged as a result of pollutant releases.

ERT — A Comstat Company

STATEMENT OF QUALIFICATIONS - HAZARDOUS WASTE MANAGEMENT SERVICES
ERT - A Comstat Company, circa 1984.

ERT is capable of providing a full range of services in the waste management consulting field. They provide general consulting on matters of policy and regulations for corporations and trade associations. They also provide evaluations of waste disposal sites and industrial property believed to contain hazardous chemicals. These programs involve site inspections, health/environmental risk assessments, development of suitable remedial action, and supervision of property restoration. Their current activity also involves site-specific evaluations of alternative waste management strategies, process optimization, RCRA delisting, preparation of RCRA Part A and Part B permit applications, development and implementation of groundwater monitoring and statistical analysis programs, establishment of closure and postclosure plans, and other aspects of achieving compliance with the ever-changing RCRA program. This resume also includes a list of personnel and their qualifications.

ETI of North America

HAZARDOUS AND TOXIC WASTE MANAGEMENT
Promotional Brochure, ETI of North America, circa 1980.

This is a packet of seven promotional brochures describing services offered by ETI of North America in the field of hazardous and toxic waste management. Services offered include: (1) professional engineering and technical assistance, (2) regulatory compliance assistance, (3) reclamation, (4) groundwater contamination, (5) surface spills, (6) PCBs and cyanides, (7) hazardous material disposal, (8) waste treatment, (9) RCRA/TSCA training seminars, (10) detoxification/stabilization, (11) mine tailings and dump material, and (12) groundwater hydrology.

Eyman, L. D.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - ANNUAL REPORT - FY 1984
DOE/HWP-6, Oak Ridge National Laboratory, February 1985.

The goal of the HWP is to support the implementation and improvement of hazardous chemical and radioactive mixed waste (HCW) management for DOE Defense Programs such that public health and safety are protected and DP missions are efficiently accomplished. (See Appendix A for supporting program objectives.) The HWP aims to achieve its goal through a strategy that includes program planning, site support, technology activities, and information systems development. Major accomplishments and future directions in each of these areas are discussed in subsequent sections of this report.

Farinoso, F. S.; Wilson, R. B.

RADWASTE INCINERATOR EXPERIENCE
EPRI NP-3250, Gilbert Associates, Inc., October 1983.

RP1557-4 is a detailed survey of the current status of operating low-level radioactive waste (LLRW) incinerators, and it compares the technology to the design requirements for use at U.S. nuclear power plants. Data are presented on incinerator design and performance for operating facilities and development prototypes in Europe, Japan, Canada, and the United States. The systems are described by subsystem categories: feed preparation, combustion chamber, off-gas treatment, and ash handling. The history of operations and maintenance is included for these operating facilities.

The incinerator types that will most likely be utilized at U.S. nuclear power plants are discussed to assess their licensability under U.S. regulations in light of the operational performance achieved on a worldwide basis.

Fitts, R. B.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - PROGRAM MANAGEMENT MANUAL
DOE/HWP-1, Oak Ridge National Laboratory, February 1985.

This manual describes the management of the HWP. The elements of the program include technology support, system integration, information support, and interagency coordination. The technology support element includes (1) national planning and overall management of technology activities, and (2) assistance in technology application in environmental restoration. The system integration element includes recommendation to DOE Headquarters (HQ) of a DOE national strategy for management of defense HCW, analysis of needs, and recommendation of operational and research actions to implement the strategy.

The objectives of this manual are to: (1) summarize the roles of management and participants in the HWP, (2) detail responsibilities and authorities for execution of technology activities and system integration, (3) define organizational interfaces and communication channels, and (4) establish procedures for planning, reporting, and budgeting of the technology tasks.

Fitts, R. B.; Ashwood, T. L.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - PROGRAM PLAN
DOE/HWP-2, Oak Ridge National Laboratory, February 1985.

The Hazardous Chemical Defense Waste Managment Program (HWP) was established in December 1983 by a Management Agreement between the Department of Energy (DOE) Office of Defense Waste and Byproducts Management (DWBM) and the Oak Ridge Operations Office. The goal of this program is to support the implementation and improvement of hazardous chemical and radioactive mixed waste management for DOE Defense Programs (DP) such that public health and safety are protected and DP missions are efficiently accomplished.

The detailed execution of the HWP is based on identified programmatic and technical priorities. In the initial phase of the program throughout most of FY 1984, the priorities are: (1) to determine the status of HCW-related technology and waste streams to provide the basis for setting future detailed priorities, and (2) to define and initiate the execution of the major program components.

There are two major components of the efforts of the program: (1) overall program management, and (2) technology activities.

Foller, P. C.; Goodwin, M. L.

ELECTROCHEMICAL GENERATION OF HIGH-CONCENTRATION OZONE FOR WASTE TREATMENT
Chemical Engineering Progress, Vol. 81, No. 3, pp. 49-51, March 1985.

Ozone is an extremely powerful oxidant, capable not only of sterilizing potable water and municipal wastes but also of decomposing many aqueous hazardous organic chemical wastes. This process is generally considered more environmentally advantageous than chlorine or hypochlorite oxidations. It is capable of precipitating certain heavy metal ions as oxides and hydroxides. Chemicals resistant to ozone oxidation alone, such as PCBs and certain pesticides, can often be decomposed by ozone acting in combination with ultraviolet irradiation (which leads to free-radical oxidation mechanisms). Ozone's advantages in waste treatment lie in the generality of its oxidations and the absence of many of the environmental consequences associated with chlorine chemical methods.

The variety of aqueous chemical waste streams that may be treated by ozone may increase substantially with the advent of electrochemical generation technology. Research and development leading towards a field test of the technology and its eventual commercial availability will be continuing.

Fore, C. S.; Holton, G. A.; Mason, P. M.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - DOE WASTE INFORMATION NETWORK - FY 1984 STATUS REPORT
DOE/HWP-5, Oak Ridge National Laboratory, February 1985.

The development of a DOE-wide network, operable by means of IBM-compatible personal computers, was initiated as part of the HWP so as to provide a mechanism for DOE-HQ, DOE Operations Offices, and their contractors to access a single, comprehensive information resource covering all aspects of hazardous and mixed waste technology. The Waste Information Network (WIN) will encompass a variety of data base systems incorporating information on DOE hazardous and mixed waste streams, sources, characteristics, disposition, and general data on the generating site; treatment, storage, and disposal technology applications and adaptations; legislative and regulatory issues on federal, state, and local levels; remedial response capabilities; and contacts for principal investigators in the field. In addition, WIN will provide a unique mechanism for transferring general or specific information between DOE-HQ, DOE Operations offices, and the contractor sites.

Fore, C. S.; Mason, P. M.; Moore, R. S.; et al.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - DOE WASTE INFORMATION NETWORK - INFORMATION SYSTEMS: DATA MANAGEMENT AND ANALYSIS
DOE/HWP-10, Oak Ridge National Laboratory, June 1985.

A major component of the Hazardous Chemical Defense Waste Management (HWP) is the development of specialized information systems encompassing all aspects of hazardous chemical and mixed radioactive waste technology. Emphasis is being placed on three key areas: (1) data base development, (2) establishment of technical information transfer mechanisms, and (3) data analysis. Emphasis to date has been on identifying, collecting, analyzing, and computerizing waste stream data for DOE installations. As a result of this effort, the Hazardous and Mixed Waste Data Base was developed for retrieval and analysis of data through the use of IBM-compatible personal computers. Various related data bases focusing on technology adaptation and application and environmental restoration (CERCLA) activities were also developed. Site visits were made to 25 DOE Defense Programs installations. Specific waste stream data for 41 DOE sites have been extracted and entered into the information system. Phase I of the national DOE Waste Information Network (WIN) was established to manage a diversity of information systems and communication features under development by the HWP.

Forsberg, C. W.

DISPOSAL OF HAZARDOUS ELEMENTAL WASTES
Environmental Science Technology, Vol. 18, No. 2, pp. 56A-62A, 1984.

The permanent, safe disposal of toxic elements such as arsenic, cadmium, and lead in hazardous wastes presents technical, political, and economic difficulties. Since the wastes are not biodegradable, they remain toxic forever; hence, shallow-land burial grounds remain toxic forever and may require perpetual maintenance. Many state regulations restrict shallow-land burial of such long-lived wastes.

A permanent (and preferable) solution to the disposal problem for wastes that cannot be detoxified or recycled would be the burial of such wastes in geological repositories 300 to 2000 m underground. In effect, the toxic elements would be recycled into the earth's crust. One such method is the RUMOD (regional underground monolith disposal) system.

The final waste form using the RUMOD method would be a series of monoliths composed of waste and a cement-based grout, with dimensions up to 25 m wide, 60 m high, and several hundred meters long.

Forsberg, C. W.; Carter, W. L.; Kibbey, A. H.

FLOWSHEETS AND SOURCE TERMS FOR RADIOACTIVE WASTE PROJECTIONS
ORNL/TM-8462, Oak Ridge National Laboratory, March 1985.

Flowsheets and source terms used to generate radioactive waste projections in the Integrated Data Base Program are given. Volumes of each waste type generated per unit product throughout have been determined for the following facilities: uranium mining, uranium enrichment, fuel fabrication, boiling-water reactors, pressurized-water reactors, and fuel reprocessing. Source terms for DOE/defense wastes have been developed. Expected wastes from typical decommissioning operations for each facility type have been determined. All wastes per unit volume are characterized by isotopic composition at time of generation and by chemical composition.

Fradkin, L.; Barisas, S.

TECHNOLOGIES FOR TREATMENT, REUSE, AND DISPOSAL OF
POLYCHLORINATED BIPHENYL WASTES
ANL/EES-TM-168, Argonne National Laboratory, January 1982.

At the present time, landfilling and incineration are the only two technologies approved for disposal of PCBs and PCB-contaminated materials. The chemical conversion of PCBs to environmentally acceptable by-products is a most desirable solution. Several technologies are being developed by private industry and government to meet U.S. Environmental Protection Agency (EPA) regulations for PCBs, including a sodium-naphthalide system, a sodium-amine method, the NaPEG (TM) process, plasma-arc, ultraviolet-ozone, catalyzed wet oxidation, hydrothermal destruction, and EPAC filters.

These technologies were assessed to assist in the selection of the best process for a particular application. Additional disposal options were evaluated, including chemical waste landfills, Annex I incineration, incineration at sea, and incineration in high-efficiency boilers. Additional incineration systems, not yet approved by EPA for commercial PCB incineration, were also examined.

Francis, C. W.; Maskarinec, M. P.; Goyert, J. C.

ENVIRONMENTAL SCIENCES DIVISION MOBILITY OF TOXIC COMPOUNDS FROM HAZARDOUS WASTES
ORNL-6044, Oak Ridge National Laboratory, August 1984.

To evaluate the potential threat to groundwater posed by improper disposal of an industrial waste in a sanitary landfill with municipal waste, a laboratory extraction procedure is needed that models the concentrations of organic and inorganic constituents in the leachate of that waste. Currently, under the Resource Conservation and Recovery Act, such mobility is determined by an extraction procedure (EP) toxicity test (USEPA 1980a). The research objective is to develop an experimental data base from which a laboratory extraction procedure (EP-III) can be selected to simulate the leaching of an industrial waste co-disposed with municipal wastes in a landfill. The intended characteristics of EP-III include the following: (1) capable of simulating leaching in a landfill containing municipal and industrial wastes in proportions of about 95 and 5% by weight, respectively; (2) compatible with biological toxicity tests (e.g., mutagenic, aquatic, and phytotoxic); and (3) relatively inexpensive to conduct in terms of time, equipment, and personnel.

Frankel, I.; Sanders, N.; Vogel, G.; Lee, C. C.

PROFILE OF THE HAZARDOUS WASTE INCINERATOR MANUFACTURING INDUSTRY
WP-81W00433, MITRE Corporation, McLean, Virginia, 1981.

The purpose of this document is twofold:

1. to present information on the number, types, and capacities of hazardous waste incinerators put into operation since January 1969, and
2. to present information which analyzes and describes some of the more important design features of the various types of incinerators.

Virtually every incinerator facility now in hazardous waste service in the United States should be equipped with at least one air pollution control device (APCD). The addition of APCDs does, of course, significantly add to incinerator capital cost requirements and operating expenses. Within the past few years, the value of thermal energy has greatly appreciated, and thermal energy release from incinerators can be significant. Accordingly, this study has shown that almost 90% of all hazardous waste incinerator facilities ordered or placed into operation during the past year have been equipped with energy recovery subsystems.

Futrell, J. W. (Publisher)

The Environmental Forum, Vol. 3, No. 7, November 1984.

The following articles are featured in the November volume:

1. EPA Enforcement: Critical Assessment Yields Mixed Review
2. Pesticide Residues in Imported Food
3. GM Challenges EPA Concern with Future NO_x/Particulate Emissions
4. Ocean Dumping of Low-Level Radioactive Waste
5. Reviewing the "Apocalyptics"
6. Are Americans Facing a "Toxics Protection Gap?"
7. NIMBY - The Siting Challenge in New England

Galbraith, G. T.; Asay, R. H.

HYDROCYCLONES FOR RADWASTE PROCESSING
EPRI NP-2338, Radiological & Chemical Technology Inc., April 1982.

Two types of hydrocyclone separators were evaluated to ascertain their applicability for processing liquid radwaste streams. The pilot-scale evaluation was conducted at the Nine Mile Point-1 BWR. Bypass streams of floor drain and filter sludge wastes were processed with the separators. Suspended solids concentration, slurry density, and particle size distribution were determined for the inlet, overhead, and underdrain streams. Typical suspended solids removal efficiencies were 82 to 89% (wt) for separator A. Removal efficiencies for separator B were significantly lower and highly variable.

The results of this study indicate that separator A could be beneficially applied to a number of radwaste processing applications. Significant radwaste volume reduction can result when waste streams of high suspended solids concentration are pretreated to remove the bulk of the solids prior to filtration through a precoat filter.

Galpin, F. L.; Meyer, G. L.; and Gruhlke, J. M.

USEPA PROGRAM TO DEVELOP LOW-LEVEL RADIOACTIVE WASTE DISPOSAL STANDARDS
Presented at AIChE meeting in Washington, D.C., 1983.

On August 31, 1983, EPA published an Advanced Notice of Proposed Rulemaking, stating the Agency's intention to develop generally applicable environmental standards for the land disposal of low-level radioactive waste (LLRW).

It is anticipated that this standard will have two important and closely related parts:

1. Establishment of a generally applicable environmental radiation protection standard to protect the public health from the hazards of land disposal of all low-level radioactive wastes.

2. Definition of radiation exposures related to radioactive waste disposal that are sufficiently small that they either do not need to be regulated regarding their radiation hazard or the wastes can be disposed of with minimal controls (i.e., a level "below regulatory concern," or BRC). Such limits would be applicable only to the actual disposal of low-level waste; it would not apply to auxiliary functions such as waste treatment, packaging, or transportation.

Gangwer, T.

DEWATERING OF BEAD AND POWDERED RESIN AT THREE MILE ISLAND UNIT 1
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 433-35, March 1985.

In an attempt to standardize a disposable shipping container for dewatered powdered resin and bead resin utilized at Three Mile Island, a systematic program was developed to approve a shipping container. The container in addition to meeting the freestanding dewatering requirement of 0.5% of waste volume or 1 gal (3.8 L), whichever is less, had to meet minimum design process capabilities of 25 gal/min (95 L/min) during resin transfer operation. Specifically, the program resulted in:

1. container definition to be used with commonly supplied casks,
2. design and fabrication of a mobile dewatering skid,
3. design and assembly of the dewatering internals for the container,
4. assembly instructions and procedures for equipment operation and dewatering,
5. procurement of hardware,
6. equipment assembly,
7. equipment setup and checkout, and
8. process control plan.

Garcia, R.; Anderson, R. E.

AEROJET FLUIDIZED-BED VOLUME REDUCTION SYSTEM OPERATION AND LICENSING
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 561-8, March 1985.

In July 1978, the Aerojet Energy Company (AECC) (Sacramento, California) was awarded a contract by Commonwealth Edison Company (Chicago, Illinois) to deliver two fluidized-bed volume reduction (VR) Systems for processing the low-level radioactive wastes at its Byron and Braidwood Nuclear Stations. The AECC VR System for Byron is fully installed and successfully completed its Acceptance Test in September 1984. In that test, three nonradioactive liquid wastes, dry wastes, and oil were processed to effect a major volume reduction of the incoming waste streams. All five waste streams were processed at rates that exceeded the specification value by at least 10%. The system processed the various waste streams for 108 h during the Acceptance Test. The VR System also successfully passed a series of 15 start-and-stop tests. As a result of the successful test operation, Commonwealth Edison Company accepted the system for operation at the Byron Station. The successful Acceptance Test of the AECC VR System and the NRC approval to operate the VR System on plant-generated wastes clearly demonstrate the applicability and licensabilty of fluidized-bed volume reduction systems for processing low-level radioactive wastes.

Garcia, R.; Spas, S. E.; Tramm, T.

LICENSING SUPPORT OF A RADWASTE INCINERATOR AT A COMMERCIAL NUCLEAR POWER STATION
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. AA1 to AA9, March 1985.

In July 1978, the Aerojet Energy Conversion Company (AECC) located in Sacramento, California, was awarded a contract by Commonwealth Edison Company (Chicago, Illinois) to provide two fluidized-bed volume reduction (VR) Systems for processing the low-level radioactive wastes at its Byron and Braidwood Nuclear Stations. The AECC VR System for Byron, consisting of a fluid-bed dryer, fluid-bed incinerator, and off-gas cleanup system, is fully installed and successfully completed its acceptance test in September 1984. During this test, the VR system processed three nonradioactive liquid waste streams, dry wastes, and oil and effected substantial volume reduction of the incoming waste streams.

This paper describes the licensing process.

Gay, R. L.; Grantham, L. F.; Jones, L. J.

SPRAY DRYING OF BEAD RESINS: FEASIBILITY TESTS
Waste Management '84, Proceedings of the Symposium on Waste Management at Tucson, ARizona, R. G. Post, ed., Vol. 2, pp. 505-9, March 1984.

Rockwell International has developed a volume reduction system for low-level reactor wastes based on drying the wastes in a heated-air spray dryer. The drying of slurries of sodium sulfate, boric acid, and powdered ion exchange resins was demonstrated in previous tests. The drying of bead ion exchange resins can be especially difficult due to the relatively large size of bead resins (about 500 to 800 μm) and their natural affinity for water. This water becomes part of the pore structure of the resins and normally comprises 50 to 60 wt % of the resin weight. A 76-cm-diam spray dryer was used for feasibility tests of spray drying of cation and anion bead resins. These resins were fed to the dryer in the as-received form (similar to dewatered resins) and as slurries. A dry, free-flowing product was produced in all the tests. The volume of the spray-dried product was one-half to one-third the volume of the as-received material. An economic analysis was made of the potential cost savings that can be achieved. A comparison of in-plant, transportation, and burial costs of spray-dried resins with similar costs for disposal of dewatered resins indicate that $600,000 to $700,000 per year can be saved by using this volume reduction system.

Gay, R. L.; Grantham, L. F.; McKenzie, D. E.

VOLUME REDUCTION OF REACTOR WASTES BY SPRAY DRYING
Waste Management '83, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 347-51, March 1983.

Three simulated low-level reactor wastes were dried using a spray dryer—baghouse system. The three aqueous feedstocks were sodium sulfate waste characteristic of a BWR, boric acid waste characteristic of a PWR, and a waste mixture of ion exchange resins and filter aid. These slurries were spiked with nonradioactive iron, cobalt, and manganese (representing corrosion products) and nonradioactive cesium and iodine (representing fission products). The throughput for the 2.1-m-diam spray dryer and baghouse system was 160 to 180 kg/h, which is comparable to the requirements for a full-scale commercial installation. A free-flowing, dry product was produced in all of the tests. The volume reduction factor ranged from 2.1 to 3.5 for solids collected at their tap density. The volume reduction factor for pelletized solids ranged from 4.5 to 10.8. The baghouse decontamination factor was typically in the range of 10^3 to 10^4. Using an overall system decontamination factor of 10^6, the activity of the off-gas was calculated to be one to two orders of magnitude less than the nuclide release limit of the major active species, ^{137}Cs.

Gay, R. L.; McCoy, L. R.; Barclay, K. M.; Grantham, L. F.

STUDIES OF THE VOLATILITY OF CESIUM AND IODINE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 357-61, March 1985.

Cesium and iodine are potentially volatile radionuclides which are present in both high-level and low-level wastes. Many volume reduction processes subject these wastes to elevated temperatures which are sufficient to cause volatilization to some extent. The volatilization of these radionuclides can have a major effect on off-gas system design and costs. In three separate tests, resins were heated from room temperature to 140, 180, and 265°C. Cesium volatilization was below the limit of detection in all tests, that is, less than 0.2% of the cesium absorbed on the resins volatilized. Iodine volatilization was detected and found to be a function of temperature, pH, and drying gas. Iodine volatilization from resins in neutral or basic media with air as the drying gas was <0.3% (less than the limit of detection) when heated at 140°C. At temperatures of 180 and 265°C, the iodine volatilization from powdered resins was 0.3 and 1.2%, respectively, and the volatilization from bead resins was 0.3 and 0.8%, respectively.

General Electric Company

VOLUME REDUCTION AND REMOVAL OF STORED IRRADIATED EQUIPMENT
Promotional Literature, General Electric Company, Waste Management Services, March 1985.

A new service is being offered by the General Electric Company for volume reduction and removal of irradiated equipment being stored in the fuel pool. Such irradiated equipment might include old fuel channels, spent control-rod blades, spent local-power, range-monitor (LPRM) detectors, poison curtains, tools, and other various equipment items accumulated over the years. Some of the new services being used for volume reduction as a part of the General Electric service are as follows:

1. plasma arc cutting machine,
2. transportation using the IF-300 cask,
3. LPRM detector cutting,
4. underwater bandsaw,
5. handling tools,
6. qualified manpower,
7. documentation and analyses,
8. site review and approval, and
9. control-rod blade handles.

General Research Corporation

STUDY OF CHEMICAL TOXICITY OF LOW-LEVEL WASTES - MAIN REPORT - VOLUME 1
NUREG/CR-1793, General Research Corporation, November 1980.

The chemical composition of fuel-cycle wastes is reasonably well known. By comparison, there is little information on the chemical composition of non-fuel-cycle wastes. Such non-fuel-cycle wastes come from a variety of sources--industrial, chemical, and medical. Because of the paucity of information, it is difficult to define the chemical characteristics and to evaluate potential hazards of non-fuel-cycle wastes as a result of chemical toxicity.

This report provides an assessment of the chemical toxicity of low-level radioactive wastes based on literature reviews, preparation of bibliographies and monographs, and application of a variety of methodologies either being currently applied or being proposed for relative hazard assessments. The report relies primarily on data from the waste disposal site at Maxey Flats, Kentucky. While there are differences between humid and dry sites, the findings are believed to be generally applicable to evaluating the chemical toxicity of wastes at all low-level radioactive waste burial sites.

General Research Corporation

STUDY OF CHEMICAL TOXICITY OF LOW-LEVEL WASTES - MONOGRAPHS - VOLUME 2
NUREG/CR-1793, General Research Corporation, November 1980.

The methodologies by which compounds, identified as possible constituents of low-level waste burial sites, were selected for toxicological review and organized into broad classes, are discussed in Sect. 1.1 of this volume. On-line computerized data bases, as well as a core collection of toxicology and chemical reference manuals and handbooks (Sect. 1.2), were utilized. To reduce the extensive list of potential low-level waste burial site constituents, only those reported by Columbo, Weiss, and Francis (1977) in trench-water analyses at the Maxey Flats, Kentucky, disposal site (Table 2-11), were used as a basis of discussion. These substances were categorized by class--alcohols, alkenes, alkyl halides, aromatic hydrocarbons, aldehydes and acetals, aliphatic halogenated and nonhalogenated hydrocarbons, esters, ethers, phenol and phenolic compounds, and organic acids. Monographs, representative of each class of compound, are presented in this volume. Each monograph summarizes the pertinent physical and chemical properties, information on use and occurrence, analytical methods, and toxicity data for the specific compound.

Ghassemi, M.; Yu, K.; Freeston, F. J.

APPLICABILITY OF COMMERCIALIZED WASTEWATER TREATMENT TECHNIQUES TO THE TREATMENT OF SPILL-IMPACTED WATERS
Environmental Protection Agency, circa 1980.

The feasibility of using reverse osmosis, ultrafiltration, ion exchange, wet-air oxidation, biooxidation, ozonation/ultraviolet radiation, and coagulation/precipitation in mobile units for on-site treatment of waters containing high contaminant concentrations at spill sites and at uncontrolled hazardous waste sites was evaluated. The criteria included lightness of weight and compactness of size, applicability to a variety of wastes, rapid startup and shutdown characteristics, and minimum requirements for skilled labor and costs. Published literature data and data obtained from process suppliers provided the bases for evaulation. Each process offers certain advantages for specific situations and, when used in combination with other processes, can provide an optimum treatment sequence for handling broader spectrums of wastes. In general, when used alone, the processes considered would not be applicable to the treatment of all wastes. However, reverse osmosis and ion exchange processes meet more of the requirements for use in spill control mobile units than the other processes considered.

Gilmer, H.; Freestone, F. J.

CLEANUP OF AN OIL AND MIXED CHEMICAL SPILL AT DITTER, MISSOURI, APRIL-MAY 1977
Environmental Protection Agency, pp. 131-134, 1977.

The Missouri Conservation Commission (MCC) and the Department of Natural Resources (MDNR) investigated complaints of fire, odor, and deteriorating creek quality in Jefferson County, Missouri. They revealed the operation of an illegal waste disposal site in conjunction with a container reconditioning operation. MDNR asked the U.S. Environmental Protection Agency, Region VII, Emergency Response Section for assistance.

Pollutants found were PCBs and BPCPE. Several actions for cleanup were decided upon, including stream bypassing, land-fill disposal, and on-site treatment of stream water.

A total cleanup was impossible.

Giuffre, M. S.; Ensminger, D. A.; Nalbandian, J. Y.

LONG-TERM, LOW-LEVEL RADWASTE VOLUME-REDUCTION STRATEGIES,
VOLUME 1: EXECUTIVE SUMMARY
EPRI NP-3763, The Analytic Sciences Corporation, November 1984.

This report provides the basis for a utility to investigate the benefits of purchasing volume reduction equipment. The work includes the establishment of a volume reduction data base, the creation of the volume reduction cost analysis, computer program VRTECH, and a generic analysis designed to identify the major factors influencing the economics of the various equipment options. Volume 1 serves as an executive summary. The second volume describes the VRTECH code and presents the results of the generic economic analysis. The work shows that radwaste generation rates and future burial price increases are the key factors in assessing the economic value of volume reduction.

Volume 3 describes several volume reduction equipment options in great detail. General arrangement drawings for generic installation are included and serve as the basis for cost estimates for the installed equipment. Volume 4 establishes pricing levels at new shallow-land burial grounds. Volume 5 is limited to a presentation of the computer results for the VRTECH economic analysis. It is on microfiche and can be found in the inside back pocket of Volume 2.

Giuffre, M. S.; Ensminger, D. A.; Nalbandian, J. Y.

LONG-TERM, LOW-LEVEL RADWASTE VOLUME-REDUCTION STRATEGIES,
VOLUME 2: ECONOMIC ANALYSIS
EPRI NP-3763, The Analytic Sciences Corporation, November 1984.

This report provides the basis for a utility to investigate the benefits of purchasing volume reduction equipment. The work includes the establishment of a volume reduction data base, the creation of the volume reduction cost-analysis computer program VRTECH, and a generic analysis designed to identify the major factors influencing the economics of the various equipment options. Volume 1 serves as an executive summary. The second volume describes the VRTECH code and presents the results of the generic economic analysis. The work shows that radwaste generation rates and future burial price increases are the key factors in assessing the economic value of volume reduction. Volume 3 describes several volume reduction equipment options in great detail. General arrangement drawings for generic installation are included and serve as the basis for cost estimates for the installed equipment. Volume 4 establishes pricing levels at new shallow-land burial grounds. Volume 5 is limited to a presentation of the computer results for the VRTECH economic analysis. It is on microfiche and can be found in the inside back pocket of Volume 2.

Giuffre, M. S.; Ensminger, D. A.; Nalbandian, J. Y.

LONG-TERM, LOW-LEVEL RADWASTE VOLUME-REDUCTION STRATEGIES,
VOLUME 3: CHARACTERIZATION OF LOW-LEVEL RADWASTE VOLUME REDUCTION INSTALLATIONS
EPRI NP-3763, The Analytic Sciences Corporation, November 1984.

This report provides the basis for a utility to investigate the benefits of purchasing volume reduction equipment. The work includes the establishment of a volume reduction data base, the creation of the volume reduction cost-analysis computer program VRTECH, and a generic analysis designed to identify the major factors influencing the economics of the various equipment options. Volume 1 serves as an executive summary. The second volume describe the VRTECH code and presents the results of the generic economic analysis. The work shows that radwaste generation rates and future burial price increases are the key factors in assessing the economic value of volume reduction. Volume 3 describes several volume reduction equipment options in great detail. General arrangement drawings for generic installation are included and serve as the basis for cost estimates for the installed equipment. Volume 4 establishes pricing levels at new shallow-land burial grounds. Volume 5 is limited to a presentation of the computer results for the VRTECH economic analysis. It is on microfiche and can be found in the inside back pocket of Volume 2.

Giuffre, M. S.; Ensminger, D. A.; Nalbandian, J. Y.

LONG-TERM, LOW-LEVEL RADWASTE VOLUME-REDUCTION STRATEGIES,
VOLUME 4: WASTE DISPOSAL COSTS
EPRI NP-3763, The Analytic Sciences Corporation, November 1984

This report provides the basis for a utility to investigate the benefits of purchasing volume reduction equipment. The work includes the establishment of a volume reduction data base, the creation of the volume reduction cost-analysis computer program VRTECH, and a generic analysis designed to identify the major factors influencing the economics of the various equipment options. Volume 1 serves as an executive summary. The second volume describe the VRTECH code and presents the results of the generic economic analysis. The work shows that radwaste generation rates and future burial price increases are the key factors in assessing the economic value of volume reduction. Volume 3 describes several volume reduction equipment options in great detail. General arrangement drawings for generic installation are included and serve as the basis for cost estimates for the installed equipment. Volume 4 establishes pricing levels at new shallow-land burial grounds. Volume 5 is limited to a presentation of the computer results for the VRTECH economic analysis. It is on microfiche and can be found in the inside back pocket of Volume 2.

Giuffre, M. S.; Ensminger, D. A.; Nalbandian, J. Y.

LONG-TERM, LOW-LEVEL RADWASTE VOLUME-REDUCTION STRATEGIES - VOLUME 5: COMPUTER RESULTS
EPRI NP-3763, The Analytical Sciences Corporation, November 1984.

This report provides the basis for a utility to investigate the benefits of purchasing volume reduction equipment. The work includes the establishment of a volume reduction data base, the creation of the volume reduction cost-analysis computer program VRTECH, and a generic analysis designed to identify the major factors influencing the economics of the various equipment options. The results are presented in five volumes. Volume 5 is limited to a presentation of the computer results for the VRTECH economic analysis. It is on microfiche and can be found in the inside back pocket of Volume 2.

Godbee, H. W.

USE OF EVAPORATION FOR THE TREATMENT OF LIQUIDS IN THE NUCLEAR INDUSTRY
ORNL-4790, Oak Ridge National Laboratory, September 1973.

A survey of evaporation as applied to radioactive waste solutions was made to evaluate the effectiveness of this unit operation as a treatment method for reducing releases of radioactive effluents to the environment from nuclear power plants. Some nuclear installations have experienced good results with evaporators - achieving decontamination factors of 10^4 to 10^6 from feed to overhead discharge. Others have experienced poor results - achieving decontamination factors of less than 10. Evaporators for radioactive waste vary from simple pots with steam-heating pipes coiled inside to elaborate devices with pumps to circulate the feed through outside heaters and compressors for recompressing the vapor to increase its temperature and permit its reuse. Technical data collected include the type of evaporators used; the kinds of ancillary equipment employed such as mist separators, condensers, and preheaters; and the important operating parameters such as vapor velocity, boilup rate, pressure, or vacuum, etc.

Godbee, H. W.; Kibbey, A. H.

THE USE OF EVAPORATION TO TREAT RADIOACTIVE LIQUIDS IN LIGHT-WATER-COOLED NUCLEAR REACTOR POWER PLANTS
NUREG/CR-0142, ORNL/NUREG-42 (REV. 1 OF ORNL-4790), Oak Ridge National Laboratory, September 1978.

Principal interest was placed upon obtaining operating data on the performance of evaporators used at LWR plants to treat radioactive liquid streams containing primarily (1) several tens to several thousand ppm of boron, (2) several tens to ten thousand ppm of boron plus several hundred to ten thousand ppm of sodium and ammonium sulfates, and (3) up to several ten thousand ppm of sodium sulfate. Included in this report are characteristics of the streams evaporated at both pressurized-water reactor and boiling-water reactor plants and the evaporator requirements for these streams. Technical data collected include the type and number of evaporators used; materials of construction utilized; the kinds of ancillary equipment employed such as gas strippers, feed filters and preheaters, and mist separators; important operating parameters such as boiloff rate, pressure, and time; and results such as volume reduction and decontamination factor obtained. The results show that a mean system DF of about 10^4 can be expected for nonvolatile fission and corrosion products treated in single-effect NC and FC evaporators and of about 10^3 in SF and SU types. The mean system DF expected for iodine is about 10^3 in the NC and FC.

Goodings, W.; Pojasek, R.; Laughlin, R.; et al.

GENERIC PROCESS TECHNOLOGIES STUDIES
Proctor and Redfern Group, Ontario Waste Management Corporation, August 1982.

The purpose of this report is to identify and evaluate liquid industrial waste and hazardous waste abatement, treatment, and disposal technologies on a generic basis. Technologies described in this report are predominantly processes which have been adopted and successfully demonstrated in full-scale applications.

The technology descriptions and evaluations in this report represent an initial screening of waste management technologies and serve as a "shopping list" for selection of appropriate special waste management strategies by the Province of Ontario. The six major technology categories described in this study are:

1. waste abatement, reduction, reuse, and recycle;
2. biological treatment;
3. physical/chemical treatment;
4. thermal processing or incineration;
5. solidification/stabilization and encapsulation; and
6. ultimate disposal.

Green, A. J.

AN ANNOTATED BIBLIOGRAPHY FOR CLEANUP OF HAZARDOUS WASTE DISPOSAL SITES
EL-82-7, Environmental Laboratory, U.S. Army Engineer Waterways Experimental Station, October 1982.

The indiscriminate and uncontrolled dumping of toxic and hazardous waste has generated environmental and health hazards in almost every state in the United States. In 1980, Congress passed legislation, commonly known as "Superfund," providing funds for cleanup of sites whose existence could not be specifically attributed to known organization and/or individiuals. The information contained herein is a bibliographical summary of the research and activities conducted in recent years that are related to the design of remedial systems for cleanup of hazardous waste sites. Health and safety is a key issue during site investigation, construction, and after-action monitoring. The nature and extent of the problem, as well as the technical and economical aspects of remedial site investigations, are discussed. The factors affecting selection of systems and alternatives for control of water and airborne contaminant are also addressed. Treatment, disposal, and storage systems available are discussed in Parts VI, VII, and VIII. Site monitoring may be required during site investigation, construction, and postclosure. Monitoring procedures are discussed in Part X.

Greer, C. W.; et al.

VITROKELE (TM) COMPOSITIONS: NOVEL, HIGH-AFFINITY, METAL-SELECTIVE, AND REGENERABLE MEDIA FOR THE REMOVAL OF RADIOACTIVE...
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 251-5, March 1985.

This paper describes new technology, the DeVoe-Holbein Technology, which provides highly efficient and effective means for handling a variety of nuclear waste streams. DeVoe-Holbein Technology consists of a novel series of synthetic (Vitrokele TM) compositions and various processes for their use. The compositions are highly efficient at metal capture, are selective for individual or groups of metals, allow high flow throughputs, are mechanically stable, and can be regenerated with small amounts of regenerant, solidified or vitrified directly.

Field and laboratory studies with actual or simulated waste streams have demonstrated the virtually complete removal of Cs, Sr, and Co from low-level wastes, while in the presence of low to high concentrations of non-radioactive competing metal ions. Systems for the in-line processing of waste streams employing capture and regeneration cycles are presented.

Westinghouse Hittman Nuclear, Inc.

SAVEPACK - MOBILE DRY ACTIVE WASTE HANDLING, COMPACTION, AND DISPOSAL SERVICES
Promotional Brochure, Westinghouse Hittman Nuclear Inc., 1984.

The Westinghouse Hittman mobile compactor is a one-of-a-kind, self-contained drum compactor housed within a 40-ft (12-m) over-the-road trailer. The unit is designed to compact 55-gal (208-L) drums of Low Specific Activity (LSA) waste at a compaction force of 1000 tons (909 kN). The compacted drums are then placed in 83-gal (314-L) overpack drums for final disposal at commercial burial grounds.

In general, equipment of this type is well suited for the waste materials produced at commercial nuclear facilities. The machine can compact anything that can be contained within a 55-gal (208-L) drum (e.g., metal, bricks, concrete blocks, paper, rags). All items do compact and although some drums do rupture during compaction, the actual contamination to the equipment is very little.

The volume of DAW shipped to a low-level burial site can be reduced by at least a factor of 2, and possibly a factor of 4.

Grom, R.; Sutter, H.

DURASIL (TM) ION EXCHANGERS: EXPERIENCE AT ARKANSAS NUCLEAR ONE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 205-10, March 1985.

Durasil (TM) ion exchangers have been used for laboratory testing, an in-plant demonstration, and full-scale processing at the Arkansas Nuclear One Generating Station (ANO). The experience gained to date indicates that the Durasils (TM) should provide: (1) significant cost savings; (2) volume reductions on the order of at least a factor of 6 over conventional organic resins; (3) reduced releases; and (4) reduced radiation exposure for personnel. These conclusions were borne out during the full-scale processing of very-high-conductivity waste at ANO.

Hanchett, J. G.; Hasselberg, F. W.; Singh, M. H.

GLOSSARY OF TERMS - NUCLEAR POWER AND RADIATION
NUREG-0770, Nuclear Regulatory Commission, June 1981.

The "Glossary of Terms: Nuclear Power and Radiation" is a compilation of words and concepts commonly used in the nuclear power field defined to assist the news media and members of the public in understanding this often complex technology. The glossary was compiled by the NRC Office of Inspection and Enforcement and the Office of Public Affairs from a variety of internal and external sources. It is a part of the agency's response to a recommendation by the President's Commission on the Accident at Three Mile Island that government agencies, utility companies, and the news media better prepare themselves to disseminate information to the public, in a form that is understandable.

Hansen, W. G. and Rishel, H. L.

COST COMPARISONS OF TREATMENT AND DISPOSAL ALTERNATIVES FOR HAZARDOUS WASTES - VOLUME I
EPA-600/2-80-188, SCS Engineers, Inc., December 1980.

Unit costs are estimated for 16 treatment and 5 disposal techniques applicable to hazardous wastes from the organic chemicals, inorganic chemicals, and electroplating and metal finishing industries. Each technology was evaluated by unit processes or modules and computer-linked models developed for calculating capital and operating costs at the unit process level. Costs were aggregated at the technology level, including applicable indirect costs and maintenance costs. Data files were designed to indicate economies of scale for five levels of throughput. Life-cycle average unit costs are presented in both tabular and graphic forms.

Hansen, W. G.; Rishel, H. L.

COST COMPARISONS OF TREATMENT AND DISPOSAL ALTERNATIVES FOR HAZARDOUS WASTES - VOLUME II. APPENDICES
EPA-600/2-80-208, SCS Engineers, Inc., December 1980.

Treatment and disposal alternatives and costs for hazardous wastes from the organic chemicals, inorganic chemicals, and electroplating and metal finishing industries are evaluated. The 16 treatment and 5 disposal technologies were based on applicability to the industry categories, availability of cost and performance data, and effectiveness in reducing or eliminating hazardous waste constituents. Costs were aggregated at the technology level and entered in computer-linked models at the unit cost or component level. Volume II contains applicable portions of the Resource Conservation and Recovery Act, capital unit cost and operation/maintenance cost data files, curve-fitting for cost files, module descriptions, and system variable equations. Voume II is intended for those desiring the supporting data for Volume I.

Hardy, D. G.; Dixon, D. F.

THE TRANSITION FROM STORAGE TO PERMANENT DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL WASTES AT THE CHALK RIVER NUCLEAR LABORATORIES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 35-41, March 1985.

A program is under way at CRNL to evolve from a policy of storage of low-level and intermediate-level radioactive wastes to one of permanent disposal. The approach being investigated is to sort the wastes into several categories graded according to their hazardous lifetime and to dispose of each category in a repository best suited to isolate and contain that waste until it no longer poses a radiological hazard. The disposal concepts selected for detailed study include an improved sand trench (IST), an intrusion-resistant shallow-land burial (SLB) facility, and a shallow rock cavity (SRC). The concept(s) adopted will depend on safety and economic criteria. The construction of a prototype SLB facility is being planned to better assess its operation, short-term performance, and economics. The paper outlines the rationale, the strategy, and the R&D work involved in the disposal program.

Hary, L. F.

CONTROLLED WASTE-OIL BIODEGRADATION AT EXISTING DRYING BEDS
GAT-S-26, Goodyear Atomic Corporation, April 1982.

A feasibility study at the Portsmouth Uranium Enrichment Facility to determine if sludge drying beds at a sewage treatment plant could be used as controlled waste-oil biodegradation plots has been completed. A greenhouse-like enclosure would be constructed over three 9.1- by 21.3-m beds to allow for year-round use, and any waste oil runoff would be collected by existing leachate piping. It has been determined that this proposed facility could dispose of existing radioactive waste oil generation (7200 L/year) from the Gaseous Diffusion Plant (GDP); however, it would be inadequate to handle radioactive waste oils from the new Gas Centrifuge Enrichment Plant (GCEP) as well. The study reviewed nuclear criticality constraints, biodegradation technology, and the capital cost for an enclosed biodegradation facility.

Hashimot, K.; Koshiba, Y.

IMPROVING VOLUME REDUCTION METHODS IN JAPAN
Nuclear Engineering International, Vol. 28, No. 338, pp. 47-48, March 1983.

Since 1970, JGC Corporation has been pursuing R&D in an attempt to develop improved radwaste treatment facilities. Work has concentrated on: (1) reducing both the radiation dose to plant personnel and environmental releases; (2) minimizing the amount of waste generated: radwaste volume reduction; and (3) effective solidification.

Three volume reduction techniques for various types of radwaste are either currently in use or about to be put into operation in Japan. They are: (1) incineration, (2) oxidation of ion exchange resin, and (3) recycling.

These three processes have been combined in the design of a novel radwaste treatment system. The system is built of six subsystems dealing with the various types of power station wastes.

Hayes, J. J.

NRC'S REVIEW CRITERIA FOR AN INCINERATOR UTILIZED AT A NUCLEAR POWER PLANT
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. Z1 to Z7, March 1985.

Lack of available low-level waste burial sites and increasing burial costs have necessitated that the operators of nuclear power plants consider various volume reduction alternatives. One of these is incineration.

Incinerators are currently planned for four plant sites serving a total of nine reactors and will be the first use of this technology at a nuclear power plant since the early 1960s. Incineration, except for small vials of liquid scintillation detector fluids or animal carcasses containing tritium or ^{14}C, requires NRC approval. This paper presents the NRC's review criteria for an incinerator utilized at a nuclear power plant.

Hazardous Materials Technical Center

Abstract Bulletin, Vol. 3, No. 1, Dynamac Corporation for the Defense Logistics Agency, Hazardous Materials Technical Center, March 1984.

The HMTC Abstract Bulletin, provides summaries of selected documents from the current scientific-technical literature on hazardous materials. The focus of the Bulletin is on the practical aspects of safety, health, storage, handling, transportation, disposal, and environmental protection in the management of hazardous materials and wastes. It is designed to be used by a wide audience, including environmental engineers, transportation and storage specialists, disposal experts, medical personnel, and other hazardous materials managers. Both published and unpublished materials are included in the Bulletin, which reflects the HMTC database--a unique information resource that does not duplicate other technical databases. The HMTC also has the capability of searching other relevant scientific and technical databases in all the major available information systems.

Heath, H. W., Jr.

INDUSTRIAL WASTEWATER TREATMENT AT DU PONT CHAMBERS WORKS "PACT" WASTEWATER TREATMENT PLANT
Presented at the Hazardous Materials Management Conference, E. I. du Pont de Nemours & Company, Inc., June 1984.

This paper discusses the 40-million-gal/day (150,000 m^3/d) industrial wastewater treatment plant (WWTP) at Du Pont's Chambers Works site at Deepwater, New Jersey. This very large WWTP uses a Du Pont-developed advanced technology to treat highly colored, acidic watewater containing a wide variety of organic compounds, including priority pollutants. Many of these compounds are not susceptible to conventional biological treatment. The advanced technology is the patented Powdered Activated Carbon Treatment (PACT owned by Zimpro, Inc.) process, which is a combined secondary/tertiary treatment. It is accomplished by adding powdered activated carbon directly to an aerator and then operating a combined biological oxidation/activated carbon adsorption process. Some noteworthy features of the Chambers works WWTP are reviewed, including a unique, 40-ton/day (36-Mg/d) regeneration furnace for powdered activated carbon and a "state-of-the-art" double-lined secure landfill where primary sludge from the WWTP is deposited. Some performance advantages of the "PACT" process over conventional activated sludge treatment are shown.

Helmholz, H. R.

DETERMINATION OF WASTE CONTAINER CURIE CONTENT FROM DOSE RATE MEASUREMENTS
EPRI NP-3223, NWT Corporation, July 1983.

A small computer program, DOSCON, was written in FORTRAN IV to calculate radwaste package millicurie content from the observed dose rate and relative radiouclide distribution. The shielding code QADMOD-G was used initially to calculate the mR/h per millicurie as a function of package density for 22 nuclides and 22 unshielded containers, including 55-gal drums, boxes, high-integrity containers, and liners. Filling materials included compacted trash, dewatered resins, and cemented concentrate. Curves are supplied for manual calculation of the millicurie content of 55-gal drums. Input to DOSCON includes identification of container type, filling material, relative radionuclide distribution, and midplane dose rate measured at 1 ft and/or 3 ft (0.3 and/or 0.9 m). The program automatically corrects for decay and calculates the total and individual nuclide concentrations at the time of dose-rate measurement and at the time of shipment. The gamma attenuation coefficients for dewatered resins and cemented wastes were determined experimentally. The calculation of buildup factors was optimized to correspond to the gamma energies and material thickness associated with normal waste packages.

Helmholz, H. R.; Palino, G. F.; Wall, P. S.; Liang, T. J.

SOLID RADWASTE RADIONUCLIDE MEASUREMENTS
EPRI NP-2734, NWT Corporation, November 1982.

Methods employed at U.S. nuclear power plants to assay low-level solid radwaste were reviewed to identify those aspects of the assay process that have substantial improvement potential and to develop recommendations on programs to develop more effective methods. Discussions were held on practices at 41 nuclear stations, and in-depth reviews were performed at 14 sites. Recommendations for future efforts were provided, particularly with reference to demonstrating adherence to proposed regulations.

Helminski, E. L. (Publisher)

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT: THE NEXT FIVE YEARS - TRANSITION TO STABILITY OR CONTINUED UNCERTAINTY - BRIEFING BOOK FOR CONFERENCE HELD AT WILD DUNES, SOUTH CAROLINA, JUNE 5–7, 1985
The Radioactive Exchange, June 1985.

This Briefing Book contains the following information:

1. forum issue briefs,
2. exhibitor information,
3. panel issues,
4. 20 speakers' papers, and a
5. comparison of the proposed regional low-level radioactive waste compacts (draft).

Henderson, J. D.; Boyd, M. A.; Marshall, R.

OPERATING EXPERIENCE WITH A DRY, ACTIVE WASTE SHREDDER/COMPACTOR AT A NUCLEAR POWER PLANT
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 523-28, March 1985.

Dry, active waste (DAW) produced at nuclear power plants generally accounts for a large portion of the total low-level radioactive waste shipped for disposal at shallow-land burial sites. Dry, active waste generally consists of paper, cloth, scrap wood, light metals, sheet plastics, and other miscellaneous items. Most nuclear plants package the compactible waste with either a drum or box compactor. Noncompactible waste is packaged in either metal or wooden boxes. The shredder/compactor system was developed to shred normally bulky noncompactible waste and thus make it capable of being compacted into an LSA box with other compactible waste. The result is the elimination of void spaces, reduced springback tendency, and an increase in the density of the waste which can be compacted into a box.

Carolina Power & Light Company installed a shredder/compactor system at the Brunswick Steam Electric Plant in October 1984. This paper describes the shredder/compactor system, the performance of the system using a simulated EPRI waste mixture, the system performance using a simulated Brunswick plant DAW mixture, and system operating experience.

Herald, W. R.; Klingler, L. M.

MOUND CYCLONE INCINERATOR, VOLUME II. ENGINEERING DESIGN REFERENCE MANUAL
MLM-MU-81-72-0003, Monsanto Research Corporation, January 1982.

The materials and information included in this volume reflect the actual operating system now in use at Monsanto's Mound Facility located in Miamisburg, Ohio. Restraints resulting from using existing equipment, facilities, and room geometry necessitated designing an incinerating system with nonoptimum engineering standards. To design a nearer-to-optimum operating incinerator, the drawings can be easily modified and adapted to fit many different room geometries and conditions. This versatility is one of the major advantages of the cyclone incinerator.

Herndon, R. C. (Director)

SOUTHERN WASTE INFORMATION EXCHANGE (SWIX) CATALOG
Southern Waste Information Exchange, Vol. 3: No. 3, November, 1984.

The Southern Waste Information Exchange (SWIX) is a clearinghouse for information concerning waste exchange and other waste managment services. SWIX operates as a nonprofit service to promote cost-effective recycling and reuse of waste materials between firms as one alternative to current waste management options. SWIX serves clients in over 34 states and works closely with generators, transporters, brokers, recyclers, and others requiring or providing waste management services in order to maximize resource reuse. The SWIX Catalog provides the means necessary for firms to explore the opportunities that exist in this area and to take advantage of these opportunities in an economical, efficient and, if desired, a confidential manner.

Hickford, G. E.; Plews, M. J.

A COMPARATIVE ASSESSMENT OF ALTERNATIVE WASTE MANAGEMENT PROCEDURES FOR SELECTED REPROCESSING WASTES
ANS Report No. 313, Associated Nuclear Services, Department of the Environment, July 1983.

This report presents the results of a study and comparative assessment of management procedures of low- and intermediate-level solid waste streams arising from current and future fuel reprocessing operations on the Sellafield site.

The characteristics and origins of the wastes under study are discussed, and a reference waste inventory is presented, based on published information.

Waste management strategy in the United Kingdom and its implications for waste conditioning, packaging and disposal are discussed. Wastes, currently arising, which are not suitable for Drigg burial or sea dumping are stored in an untreated form. Work is being done to provide additional and improved disposal facilities which will accommodate all the waste streams under study.

Hill, R. D.

CURRENT SHWRD PROGRAM IN SUPPORT OF SUPERFUND
Environmental Protection Agency, 1984.

The Solid and Hazardous Waste Research Division (SHWRD), Municipal Environmental Research Laboratory, has the responsiblity for the control development program in support of the "Superfund." The SHWRD research and development program has been organized to correspond with the "Superfund" legislation; i.e., the Oil and Hazardous Materials Spills Branch deals with removal actions (emergencies), and the Disposal Branch deals with remedial actions. The program is one of technology assessment to determine cost and effectiveness, adaptation of technologies to the uncontrolled waste site problem, field evaluation of technologies that show promise, development of guidance material for the EPA Office of Emergency and Remedial Response (OERR), and technical assistance to the OERR and EPA Regional Offices. The Removal Program is divided into three major areas of activity: (1) personal health and safety, (2) demonstration of equipment, and (3) chemical countermeasures. The remedial action program is divided into three major areas of activity: (1) survey and assessment of current technologies, (2) field demonstration and verification of techniques, and (3) site design analysis. An overview of the removal and remedial program is presented.

Hirschhorn, J. S.; Pirages, S.; Larsen, K.; Goodman, I.; et al.

TECHNOLOGIES AND MANAGEMENT STRATEGIES FOR HAZARDOUS WASTE CONTROL
U.S. Congress, Office of Technology Assessment, circa 1983.

This assessment focuses on:

1. information and analysis on the use and development of technologies that can improve hazardous waste management through: (a) reduction of the volume and hazard level of the waste generated; (b) better management of the risks associated with waste treatment and disposal; and (c) the cleanup of uncontrolled waste sites;
2. analysis of the potential benefits and cost of a framework based on scientific criteria to judge the relative degree of hazard of wastes and risks from management facilities; and
3. evaluation of current regulatory programs, particularly with regard to technical information and issues.

The primary focus of this assessment is on management strategies, technological options, and the techical components of a Federal hazardous waste regulatory program that would protect human health and the environment.

Holberger, R. L.

THE DEVELOPMENT AND IMPLEMENTATION OF THE HAZARDOUS WASTE CONTROL TECHNOLOGY DATA BASE - VOLUME 1 - OVERVIEW
MTR-84W7-01, MITRE Corporation, December 1983.

The Hazardous Waste Control Technology Data Base (HWCTDB) is an automated data base sponsored by EPA's Incineration Research Branch to store detailed technical data relevant to the thermal destruction of hazardous wastes. The data base stores design, operating, and performance data obtained from incineration facility permit applications, trial burn reports, research and development projects, and literature sources. The data base went on-line in late 1982. This report documents the development and implementation of the data base, contains a detailed description of its structure and contents, and outlines the procedures for accessing and utilizing the information it contains.

Holberger, R. L.

APPENDIX A - HAZARDOUS WASTE CONTROL TECHNOLOGY DATA BASE - DATA DICTIONARY
MTR-84W7-02, MITRE Corporation, December 1983.

This appendix contains a data dictionary that describes the individual data elements comprising the HWCTDB. The entries for each data element consist of: the element name and number, its description/definition, its attributes, and the appropriate editing information and/or data codes (when they exist). The attributes of a data element include its length (i.e., the total number of characters or digits reserved for the element, excluding the decimal point of numeric data) and its type (character or numeric). Character data may include numbers; however, such numbers would not be used for computations (e.g., street numbers, phone numbers, numeric codes, etc.). As required by System 2000, numeric data are stored in fixed-point formats and are assumed to be integers unless specified in the form [9(N).9(M)], where N is the number of digits before the decimal point and M is the number of digits following the decimal point.

Holberger, R. L.

APPENDIX H - HAZARDOUS WASTE CONTROL TECHNOLOGY DATA BASE SYSTEM DOCUMENTATION/USER GUIDE
MTR-84W7-03, MITRE Corporation, December 1983.

The Hazardous Waste Control Technology Data Base (HWCTDB) User's Guide consists of the following sections:

1. Overview - The overview provides a general introduction and a description of the HWCTDB system data base and the data flow. Pages in this section are numbered beginning with "H".
2. Screen Entry - The screen entry section contains instructions for entering data into the HWCTDB. Pages in this section are numbered beginning with "I".
3. Reports and Retrievals - The reports and retrievals section provides instructions for generating system reports and ad hoc retrievals from the WCTDB. Pages in this section are numbered beginning with "J".
4. Data Element Dictionary - The data element dictionary is a reference guide which describes each of the components in the HWCTDB. Pages in this section have a prefix of A.
5. Appendixes - Appendix K provides samples of HWCTDB standard reports and the computer prompts that are used to generate the reports.

Holland, M. E.

USE OF XANTHATES FOR THE REMOVAL OF METALS FROM WASTE STREAMS
GAT-826, Goodyear Atomic Corporation, October 1975.

A laboratory investigation was conducted to determine the technical feasibility of producing large quantities of the xanthate derivatives of corn starch, straw, sawdust, and cellulose filter cartridges for use in the removal of dissolved metals from wastewater. Xanthation of these materials was found to be increasingly easier in the order of: sawdust < straw < starches < pure cellulose. The capacity of the xanthates of these materials to remove dissolved metals from aqueous solutions was found to vary considerably as a result of their degree of xanthate formation. The cellulose filter cartridges and corn starch xanthates were the most efficient by removing 98 to 100% of the dissolved metals, and the straw and sawdust xanthates were the less efficient by removing 42 to 80% and an average of 30%, respectively. Several disadvantages are apparent in the use of xanthates for routine water treatment, including (1) high-pH effluent streams, (2) discoloration of the water, and (3) strong odors when the xanthates are allowed to decompose.

Hollo, T.; White, R. G.

PREPARING FOR HIGH-TONNAGE PRESS PROCESSING OPTIONS
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. F1 to F33, March 1985.

High-tonnage compactors are available in a variety of forms. With the options of direct purchase or use of regionalized service facilities, even the small waste generators can realize significant volume reduction without major capital outlay. Full advantage can be taken of the volume reduction capabilities of high-tonnage compaction, through effective use of precompaction to control shipping and container costs, by considering that the container is a consumable and using the least expensive container for initial packaging, and finally by adding subsystem machinery to allow sizing of all noncompactibles to fit into 55-gal drums.

Holmes, J. A.

PERMITTING STRATEGIES FOR A MULTIPURPOSE HAZARDOUS WASTE STORAGE AND AND TREATMENT FACILITY
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. BB1 to BB32, March 1985.

Stanford University has been in the process of planning a multipurpose hazardous waste storage and treatment facility, which will also house all other health and safety-related activities, since the summer of 1982. This paper provides an update on the progress made and specifically addresses the permitting issues. The local permitting process is one which had been underestimated, both as to the time required and the potential financial impacts on the project. This paper focuses particularly on one aspect of local permitting, namely the Environmental Impact Report. While the radiological impacts of the facility were minimal, the public and public agencies voiced a number of concerns about radiological safety during their review. The project staff and the EIR consultants also found that the State's Radiological Health Branch was not experienced in the EIR review process. The paper cites the other permitting requirements and estimates the time requirements to complete the review by the eight agencies involved.

Huibregtse, K. R.; Kastman, K. H.

DEVELOPMENT OF A SYSTEM TO PROTECT GROUNDWATER THREATENED BY HAZARDOUS SPILLS ON LAND
Rexnord, Inc. and Oil Testing Services, Inc., 1979.

Treatment of hazardous materials spills onto land that create threats to the quality of groundwater is frequently limited to excavation or flushing the area with water. The purpose of this project was to establish an alternative approach to the solution of the problem. The objective was to develop, design, and construct a vehicle capable of containing about a 10,000-gal (37.8-m^3) hazardous spill on contaminated land and treating the polluted soils by oxidation/reduction, neutralization, precipitation, or polymerization. The approach was to use direct injection of grout into the soil around the contaminated area to envelop the spill and isolate it from the groundwater and then detoxify the spill area by injection of treatment agents. Detoxification in flow-through tests exceeded 99% of the initial contaminant added and appeared to be the result of both displacement and chemical reaction. Sealed test detoxification efficiencies in clays ranged from 56.5 to 99.5%. A simultaneous evaluation of grout formulations and injection devices indicated that grouting was most applicable in gravel, sand, and some silty soils. Two types of grout (bentonite/cement and sodium silicate) were selected as most applicable.

Hunkele, W.;Jensen, C. E.

LIQUID RADWASTE PROCESSING, OPERATIONAL EXPERIENCE UTILIZING DURATEK MOBILE PROCESS SYSTEM (MPS)
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 569-71, March 1985.

The use of Duratek's Mobile Process System (MPS) employing sluiceable pressure vessels and improved operational techniques generates operational efficiencies, including volume reduction (VR), reduced personnel labor and exposure, and higher flow rates for cleanup of liquid radwaste streams in an operating nuclear power plant (Salem Generating Station).

Significant additional VR is achievable based on laboratory and on-site experience utilizing Durasil (TM) 70. Under high-conductivity actual waste stream conditions, this proprietary medium has demonstrated throughputs 15 times higher than that of organic cation resin. A long-term problem, cobalt species removal, is mitigated by this medium.

Hunsaker, C. T.

OCEAN DUMPING OF LOW-LEVEL RADIOACTIVE WASTE
The Environmental Forum, pp. 24-31, November 1984.

Ocean dumping as defined in the Marine Protection, Research, and Sanctuaries Act (MPRSA), is the seaward transport of land-generated wastes by ships, barges, platforms, or aircraft and the disposition of those wastes in the marine environment. Such wastes may be dumped in bulk or in containers, incinerated, or emplaced in the seabed. Most low-level wastes dumped at sea have been in containers; however, that method was used to facilitate disposal operations and not to prevent release of radioactivity once the waste was in place on the seafloor. Ocean dumping is viewed as an alternative to land burial for several reasons: (1) the possible economic advantages; (2) the Navy's need to dispose of decommissioned nuclear powered submarines; (3) the DOE's need to dispose of large amounts of slightly contaminated soils; and (4) the requirement that states evaluate waste disposal needs according to the Low-Level Radioactive Waste Policy Act of 1980. This article reviews U.S. laws and international agreements that relate to ocean dumping of low-level radioactive waste and discusses their interrelationships and implications for future ocean dumping proposals.

Hunsaker, C. T.

RADIOACTIVITY IN THE OCEAN: LAWS AND BIOLOGICAL EFFECTS
Coastal Zone '85, Vol. 1, pp. 629-48, August 1985.

This paper summarizes the literature on U.S. laws and international agreements, experimental and monitoring data, and ongoing studies to provide background information for environmental assessment and regulatory compliance activities for ocean dumping of low-level radioactive waste. The Marine Protection, Research, and Sanctuaries Act is the major U.S. legislation governing ocean disposal of radioactive waste. The major international agreement on ocean dumping is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. The United States ended its ocean dumping of radioactive wastes in 1970, but other countries have continued ocean dumping under international supervision in the northeast Atlantic. Monitoring of former U.S. disposal sites has neither revealed significant effects on marine biota nor indicated a hazard to human health. Also, no effect on marine organisms have been found that could be attributed to routine discharge into the Irish Sea from the Windscale reprocessing plant. We must improve our ability to predict the oceanic carrying capacity and the fate and effects of ionizing radiation in the marine environment.

Hushon, J; Saari, S.; Small, R.; Thoman, D.; et al.

BASELINE PLAN FOR DESIGN OF A HAZARDOUS SUBSTANCES MONITORING PROGRAM
MTR-7918, The MITRE Corporation, September 1978.

MITRE has prepared a baseline plan for a German monitoring program for determination of hazardous substances in the environment. Criteria for sampling and the steps involved in a residue monitoring program have been developed. Chemicals are ranked on the basis of their potentials for toxicity, persistence, and accumulation in the environment. For each chemical, the environmental compartments where these chemicals are most likely to persist are identified. The compartments to be monitored are defined, with examples given for each.

HWERL - Cincinnati; Edison, New Jersey

IN-SITU TREATMENT AND SOIL WASHING PROGRAM
HWERL, November 2, 1984.

"Superfund" recognizes the need to develop countermeasures (mechanical devices, and physical, chemical, and biological agents) to mitigate the effects of hazardous substances that are released into the environment and to clean up inactive hazardous waste disposal sites. The objective is to define technical criteria for the use of chemicals (e.g., surfactants, neutralization, oxidation/reduction, precipitation agents, etc.) and other additives (e.g., biostimulants and bacterial cultures) at release situations such that the combination of released substance plus the chemical or other additive, including any resulting reaction or change, results in the least overall harm to human health and to the environment.

Hydro Nuclear Services

DAW SEGREGATION/VOLUME REDUCTION PROCESS
Promotional Brochure, Hydro Nuclear Services, November 1984.

The dry, active waste (DAW) produced in nuclear power plants consists of a large volume of material that usually contains a significant percentage of noncontaminated items mixed with the contaminated waste. Although attempts are made to collect separately this noncontaminated material from radiologically controlled areas, these attempts are usually not successful and clean material is often mixed with contaminated material and the lot is disposed as contaminated waste. To assist the nuclear power industry in maximizing its efforts to reduce the amount of low-level waste being shipped to burial sites, Hydro Nuclear Services (HNS) initiated an extensive research and development effort to design and test an automated process for dry, active waste segregation. This process, often referred to as the "DAW System," incorporates state-of-the-art waste monitoring and processing equipment and is supported by a team of highly trained technicians and engineers. The result is a dry, active waste segregation/volume reduction process that is economical, reliable, and consistent with all applicable regulatory guidelines.

ICF, Inc.

THE RCRA RISK-COST ANALYSIS MODEL - PHASE III REPORT
Environmental Protection Agency/ICF Inc., March 1, 1984.

The RCRA Risk-Cost Analysis Model is intended to support the development of regulations authorized by the Resource Conservation and Recovery Act (RCRA) to control the treatment, storage, and disposal of hazardous waste. This report describes the model. For each possibility, the model calculates the risks and costs involved.

There are three main factors considered in the model's formulation of possible ways to manage waste: (1) the type of waste; (2) the types of technologies used to treat, transport, store, and dispose of the wastes; and (3) the environmental settings in which the wastes are generated, treated, and disposed. The model then calculates the risks and costs involved in each possiblity for managing hazardous waste.

ICF, Inc.

THE RCRA RISK-COST ANALYIS MODEL - PHASE III REPORT - APPENDICES
Environmental Protection Agency/ICF, Inc., March 1, 1984.

ICF, Inc., developed the RCRA Risk-Cost Analysis Model to support the development of regulations governing the treatment, storage, and disposal of hazardous waste.

These appendices contain additional data, detailed descriptions of key components of the model, and background studies.

Idaho National Engineering Laboratory (INEL)

INEL WASTE EXPERIMENTAL REDUCTION FACILITY
Idaho National Engineering Laboratory (INEL), August 22, 1984.

The Waste Experimental Reduction Facility (WERF) is a waste processing facility established at the Idaho National Engineering Laboratory (INEL) to reduce the volume of low-level, beta/gamma-contaminated waste being disposed of at the radioactive waste disposal site and thereby prolong the disposal site's useful life; and to develop waste processing technology by providing a facility where full-size processes and equipment can be tried, modified as necessary, and proven for contaminated waste processing applications.

At WERF, capabilities are being developed to: (1) size-reduce contaminated metal at the rate of several hundred tons per year (several hundred Mg/year); (2) decontaminate metal by removing grease and dirt with a Freon cleaner and removing other contamination by electropolishing in a bath of phosphoric acid; (3) melt contaminated metal at the rate of several hundred tons per year (several hundred Mg/year) and cast it into ingots for disposition; and (4) incinerate contaminated combustible waste at the a rate of 400 lb/h (180 kg/h).

Iji, T.; et al.

ADVANCED CEMENT SOLIDIFICATION PROCESS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 211-16, March 1985.

The Advanced Cement Solidification Process, which features improved volume reductivity and properties of solidified wastes, has been developed to establish a better radioactive waste management system. Cement has been widely used as an inorganic solidification agent for the treatment of radioactive wastes generated at nuclear facilities. With current technology, borate waste solutions generated at PWR plants are neutralized with caustic soda and solidified directly with cement. This method causes an increase in the volume of waste. Moreover, since borates retard the hydration of cement, the properties of solidified waste are not always such that they would meet the final disposal requirements. In order to eliminate these defects and to improve conventional cement solidification processes, the Société Générale pour les Techniques Nouvelles and JGC Corporation have conducted cooperative research, especially basic research on the pretreatment of borate. As a result of numerous experiments, a new process has been developed in which research and development work on a pilot plant have been carried out in cooperation with the Kyushu Electric Power Co., Inc., including small-scale hot tests of actual wastes. Several successful proving tests have been conducted at a cold pilot plant.

International Atomic Energy Agency

CHEMICAL TREATMENT OF RADIOACTIVE WASTES
Technical Reports Series No. 89, International Atomic Energy Agency, 1968.

This manual is a review of coagulation-flocculation and sedimentation processes, commonly called "chemical treatment," as they are applied to decontamination of low-activity wastes. Its purpose is to present the subject in a condensed form and to summarize results recently published, especially those given in the proceedings of the IAEA symposium on treatment of low-activity wastes.

Although the major topic of this manual is coagulation-flocculation and sedimentation, it has been deemed necessary to review briefly several related techniques (preoxidation, filtration, sludge conditioning) which directly affect the utilization of the chemical-treatment process.

The various chapters have been arranged to provide the user of this decontamination method with practical information to assist in the design and utilization of a plant without making it too large or including any unnecessary luxury, at the same time observing the national and international standards governing releases to the environment.

International Atomic Energy Agency

CONDITIONING OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTES
Technical Reports Series No. 222, International Atomic Energy Agency, 1983.

This technical report describes primarily the technologies available for the conditioning steps (i.e., immobilization and packaging) and relates them to the other steps. In broad terms, the purpose of conditioning is to convert the wastes into packages that are suitable for transport, storage, and disposal. In the context of this report, the objectives of immobilization are to convert the wastes into forms which are: (1) leach resistant so that the release of radionuclides will be slow even though flowing water may contact them; (2) mechanically, physically, chemically, and radiologically stable for at least all stages of the handling, transport, and interim storage up to the time of actual disposal. Ideally, it would be desirable that the waste forms remain essentially stable for the hazardous lives of the waste; however, in the case of long-lived alpha-bearing wastes, this condition cannot be assured. These objectives can be more easily achieved by immobilization processes if the original wastes first undergo treatment processes to reduce their volumes and remove extraneous volatile or oxidizable fractions. These treatment processes are reviewed only briefly in this report; however, the immobilization processes are outlined.

International Atomic Energy Agency

DESIGN AND OPERATION OF EVAPORATORS FOR RADIOACTIVE WASTES
Technical Reports Series No. 87, International Atomic Energy Agency, 1968.

Evaporation is a commonly used technique for concentrating waste liquids containing radioactive materials. Because of its capability of a high degree of separation for most radioactive materials and its inherent high cost, evaporation is generally confined to the treatment of intermediate- or high-activity wastes. Advantages and disadvantages of evaporation are discussed along with problems encountered in evaporator operation. Characteristics of the various types of evaporators are described. The information is based on actual operating experiences at a number of nuclear installations.

International Atomic Energy Agency

DISPOSAL OF RADIOACTIVE GROUTS INTO HYDRAULICALLY-FRACTURED SHALE
Technical Report Series No. 232, International Atomic Energy Agency, December 1983.

The present report deals with an original method of disposal of radioactive wastes which was developed and has been in use in the United States for almost two decades.

In this method, radioactive waste effluents in the form of a slurry containing hydraulic binders (grouts) are injected by means of fracturing into a deep underground formation considered to be isolated from the surface. The composition of the grout is carefully chosen so that the slurry thus injected solidifies in situ, ensuring fixation of the waste and rendering this type of disposal final in character.

International Atomic Energy Agency

NUCLEAR WASTE MANAGEMENT GLOSSARY (Draft Report)
International Atomic Energy Agency, April 1981.

Terminology used in documents published by the IAEA is frequently defined in glossaries in the separate documents so that understanding is enhanced, particularly for terms having unique meanings in the field of nuclear waste management. This has been found to be a good practice but frequently a burdensome one, too. In addition, terms in various documents occasionally were used differently. Thus, a common glossary of terms for nuclear waste management documents is believed to have merit.

This glossary has been developed for use in IAEA documentation on nuclear waste management topics. The individual items have been compiled by selecting terms and definitions from 30 sources listed in the key. An effort has been made to use definitions in internationally accepted glossaries [e.g., ISO(1)] with minimum modification; similarly, definitions in recently published IAEA documents have been respected. Nevertheless, when modifications were believed appropriate, they have been made and an M has been added after the source reference number.

International Atomic Energy Agency

OPERATION AND CONTROL OF ION-EXCHANGE PROCESSES FOR TREATMENT OF RADIOACTIVE WASTES
Technical Reports Series No. 78, International Atomic Energy Agency, 1967.

The three principal techniques of concentration are chemical precipitation, evaporation, and ion exchange. One of the most attractive methods, particularly from considerations of efficiency and volume reduction, has been ion exchange. Radionuclides are sorbed from water flow streams by natural or artificial media at decontamination factors exceeding 1000 in some cases. Large varieties of ion-exchange materials are available in different physical forms with a wide range of capacities for prices varying by orders of magnitude. Many nuclear energy installations throughout the world have included ion-exchange techniques in their radioactive waste control programs. Selected advantages of materials and methods have often determined ion exchange as the most economically feasible waste control tool. This manual will attempt to acquaint the readers with the chemistry and technology of ion exchange as it can be, and has been, adapted for treatment of radioactive wastes. By review of the material herein, it should be possible to decide whether use of these phenomena is applicable to problems at hand, whether space is available, whether manpower is adequately trained, and whether costs would be within the budget.

International Atomic Energy Agency

RADIOACTIVE WASTE MANAGEMENT
Proceedings of an International Conference, Vol. 2, International Atomic Energy Agency, May 1983.

This volume includes the following:

1. Waste Handling, Treatment and Conditioning at Nuclear Facilities (Session B.1.) - eight papers and summary discussion
2. Handling, Treatment, and Conditioning of Waste from Nuclear Power Plants (Session B.2.) - six papers and summary discussion
3. Handling, Treatment, and Conditioning of Waste from Reprocessing Plants: National Experience (Session B.3.) - six papers and summary discussion
4. Handling, Treatment, and Conditioning of High-Level and Specific Wastes from Reprocessing Plants (Session B.4.) - eight papers and summary discussion
5. Handling and Treatment of Other Wastes, Including Gaseous, Decommissioning, etc. (Session B.5.) - seven papers and summary discussion

International Atomic Energy Agency

RADIOACTIVE WASTE MANAGEMENT
Proceedings of an International Conference, Vol. 3, International Atomic Energy Agency, May 1983.

This volume includes the following:

1. Session C.1.1. - Storage and Disposal of Radioactive Waste: General Aspects - eight papers and Summary of Discussion
2. Session C.1.2. - Storage and Disposal of Radioactive Waste: National Concepts - six papers and Summary of Discussion
3. Session C.2.1. - Storage and Disposal of High-Level Waste: Underground Pilot Projects - seven papers and Summary of Discussion
4. Session C.2.2. - Diposal of High-Level Waste: Repository Concepts - seven papers and Summary of Discussion
5. Session C.3. - Disposal of Low- and Intermediate-Level Wastes - seven papers, of Discussion and List of Chairmen of Sessions and Secretariat of the Conference

International Atomic Energy Agency

TREATMENT OF LOW- AND INTERMEDIATE-LEVEL SOLID RADIOACTIVE WASTES
Technical Reports Series No. 223, International Atomic Energy Agency, 1983.

This document describes the treatment of low- and intermediate-level solid waste prior to its conditioning for storage or disposal. Owing to the rather large number of waste sources, considerable practice has been accumulated in the nuclear community, and industrial-scale handling facilities have been, and continue to be, successfully demonstrated.

Apart from the description of existing facilities and demonstrated handling schemes, this report provides the reader with the basis for a judgment that facilitates the selection of appropriate solutions for a given solid-waste management problem. It thus aims at providing guidelines in the particular field and indicates new promising approaches that are actually under investigation and development.

International Atomic Energy Agency

THE VOLUME REDUCTION OF LOW-ACTIVITY SOLID WASTES, Technical Reports Series No. 106, International Atomic Energy Agency, 1970.

At some establishments, solid wastes can be easily stored in the vicinity. In many cases, however, this cannot be done. If the wastes have to be specially packaged for final storage or transport, their volume or dimensions must be reduced so that they can be efficiently and economically packaged in the transport or storage container. Although various reduction techniques have been developed, most of the methods of volume reduction can be included in one of two main categories: (1) mechanical techniques, such as fragmentation and compacting; and (2) incineration.

The mechanical techniques yield a reduction in volume only, whereas incineration yields a reduction in both volume and weight. The degree of reduction is generally indicated by the reduction factor, which is the ratio between the initial volume (or weight) and the final volume (or weight). Although both methods may seem applicable to most wastes, they are actually complementary rather than competitive. The techniques described are intended mainly for wastes of large volume and low activity; however, it will be seen that some of them can be used for higher activities, the only difference being the need for protective shielding and more thorough containment.

Issler, H.; McCombie, C.

DEMONSTRATION OF THE FEASIBILITY OF SAFE DISPOSAL OF RADIOACTIVE WASTES: THE SWISS APPROACH
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol 1, pp. 55-60, March 1985.

In Switzerland, the further development of nuclear energy and the continuing use of current power plants were made conditional upon the preparation of a project, indicating the feasibility of safe disposal of nuclear wastes. The required scope of the project is wider than in other countries since it includes all wastes from reprocessing, from plant operation and from non-power-production sources. At the beginning of 1985, documentation on the work performed by Nagra in the last 6 years to produce appropriate projects was submitted for government review. The concepts developed are: (1) for a deep repository in crystalline bedrock, which will accommodate high-level vitrified wastes and possibly some actinide wastes from reprocessing; and (2) for a horizontallly accessed repository in marl for all other wastes, including voluminous decommissioning wastes. Aspects documented include the characterization of all wastes, the engineering of both repository types, and the long-term safety analyses. The results given are based on an extensive program of laboratory work, field measurements, and analyses. Geological data from Swiss site investigations are used, although no specific repository sites have been fixed at present.

JACA Corporation

INCINERATION AND TREATMENT OF HAZARDOUS WASTE - PROCEEDINGS OF THE TENTH ANNUAL RESEARCH SYMPOSIUM AT FT. MITCHELL, KENTUCKY
EPA-600/9-84-022, Environmental Protection Agency, April 1984.

The Tenth Annual Research Symposium on Land Disposal, Remedial Action, Incineration, and Treatment of Hazardous Waste was held in Fort Mitchell, Kentucky, April 3 through 5, 1984. The purpose of the symposium was to present to persons concerned with hazardous waste management the latest significant findings of ongoing and recently completed research projects funded by the Industrial Environmental Research Laboratory's Energy Pollution Control Division and the Municipal Environmental Research Laboratory's Solid and Hazardous Waste Research Division.

This volume is a compilation of speakers' papers and poster presenters' abstracts for Session B, Hazardous Waste Incineration and Treatment. Subjects include innovative technology, laboratory-scale research projects, pilot- and full-scale incineration projects, combustion of hazardous waste in boilers and in industrial processes, and hazardous waste treatment and cost studies. This document covers hazardous waste incineration and treatment only. A separate document for Session A, Hazardous Waste Land Disposal, is available from the Municipal Environmental Research Laboratory.

Jacob, N. P.; et al.

RADWASTE ION-EXCHANGE OPTIMIZATION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 573-78, March 1985.

Increased volume reduction factors for radwaste liquid treatment and reduced costs for ion-exchange media replacement and disposal have been key driving forces for nuclear utilities to seek optimal performance from radwaste liquid ion-exchange treatment systems. This paper presents the methodology and the results of an EPRI/B&W project to identify optimal radwaste ion-exchange processing schemes that will provide cost savings for nuclear plant operators. The focus in this paper will be on the findings of both in-plant bench-scale and prototype ion-exchange column tests using radwste liquid generated at the Millstone Nuclear Station.

Jacobs, M. H.; Miller, C. C.; Young, L. G.

DETERMINATION OF THE MAXIMUM JUSTIFIABLE CAPITAL EXPENDITURES FOR VOLUME REDUCTION SYSTEMS
Presented at the American Nuclear Society, Reactor Operations Division Meeting, Sargent & Lundy Engineers, August 1983.

Costs associated with the disposal of low-level radioactive waste have increased dramatically over the last 10 years. The cost of transportation has increased by an amount equivalent to 7% per year over the last 8 years, and the burial costs have increased over 40% per year in the same period. With these rapidly increasing costs, many utilities are considering the installation of new volume reduction equipment in an attempt to reduce the volume of radioactive waste that must be disposed of each year, thereby reducing the disposal cost.

The purpose of this paper is to demonstrate that the equivalent capital investment (ECI) method of economic evaluations is a convenient means for determining the justifiable capital investment for a VR system backfit. Although other methods, such as the present value of revenue requirements method, yield equivalent results regarding the relative ranking and percentage difference among alternatives, the ECI method is preferable when the number resulting from an analysis is to be compared directly with capital investment costs.

Jacobs., M. H.; Miller, C. C.; Young, L. G.

LOW-LEVEL RADWASTE ENGINEERING ECONOMICS
EPRI NP-3577, Sargent & Lundy Engineers, July 1984.

This topical report on engineering economics for low-level radwaste systems details the methodologies used for economic analyses of radwaste treatment systems and provides examples of radwaste economic evaluation. All of the parameters and cost items used in an evaluation are defined. Examples of the present-value-of-revenue-requirements method, levelized-revenue-requirements method, and the equivalent-capital-investment method are provided. Also, the calculation to determine the maximum justifiable capital expenditure for a radwaste system is illustrated. The report also provides examples of economic evaluations for many current radwaste treatment options. These options include evaporation versus demineralization, dewatering resins versus solidification of resins, and several volume reduction systems.

Jefcoate, I. A.

1984 SURVEY OF RESEARCH ON ENVIRONMENTAL POLLUTION - ITS SOURCES, FATE, EFFECTS, AND CONTROL
BER Report No. 345-121, University of Alabama, June 1985.

The Environmental Research Committee of the AIChE, a joint committee of the AIChE Environmental Division and of the AIChE Research Committee, conducted a survey in 1973 of environmentally related research and/or design projects in progress at U.S. colleges and universities. Because of the large number of chemical engineers involved with and concerned about environmental projects, the Environmental Research Committee in 1983 decided to update the earlier survey and extend it to include industrial research. Of interest was how the research effort had changed, or shifted, from 1973 and what were the perceived environmental research and design needs of the respondents. A revised version of the 1973 questionnaire was mailed in December 1984, with the responses collected until March 1985. This report presents the results of the 1984 survey.

A separate appendix to this report containing the individual survey responses has been prepared for the U.S. Environmental Protection Agency to make available through NTIS.

Jessop, D.; McRee, B.

OPERATION OF CONTROLLED-AIR INCINERATORS AND DESIGN CONSIDERATIONS FOR CONTROLLED-AIR INCINERATORS TREATING RADIOACTIVE WASTES
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, p. A1, March 1985.

The intent of this paper is to review design philosophy of all controlled-air incinerators and make conclusions concerning the proper operation of this equipment. It also discusses special considerations in the design of incinerators treating radioactive wastes. The paper will provide a brief history of controlled-air incineration and define the term "controlled air." In order to fully understand the principles of controlled-air incineration, some basic chemistry of combustion will be presented. The paper discusses excess air and how it affects operating parameters, including chamber temperatures, effluent compositions, and particulate emissions. The conditions and processes taking place within a controlled-air incinerator will be summarized. A series of commonly incinerated waste materials will be examined so that operating paramenters, such as combustion temperatures and amount of excess air, can be established. The paper will specifically address the incineration of materials high in fixed carbon content and describe how they are handled in controlled-air incinerators. Finally, the paper will present some special design and operating requirements for incinerators treating radioactive materials.

Johnson, A. J.; Meile, L. J.; Jaskot, G. F.

COMMERCIAL AND DEFENSE NITRATE WASTES AND PROCESSING ALTERNATIVES
RFP-3282, Rockwell International, August 1982.

Nitric acid is extensively used at commercial and defense facilities engaged in nuclear fuel reprocessing and/or actinide recovery and purification. The high-volume usage of nitric acid results in the generation of large amounts of nitrate wastes. Commercial facilities in the nuclear fuel cycle report that they are able to handle most of their nitrate waste under current discharge limits but could have problems if these limits are lowered. The defense nuclear facilities generate, by far, the greater amount of waste nitrates. A separation system now planned for HLW at SRP will convert large volumes of stored waste into a concentrated volume of HLW and large volumes of LLW nitrates. No processing systems are now operating that will produce a desirable final waste form. Several methods have been identified that could be used to destroy or convert the nitrate compounds to a waste more amenable to conversion into an acceptable waste form for final disposal.

Johnson, A. N.

VOLUME REDUCTION THROUGH DRY, ACTIVE WASTE SEGREGATION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 197-200, March 1985.

Dry, active waste (DAW) segregation programs offer the benefits of radioactive waste volume reduction and recovery of reusable materials, but at the same time they pose the risk of release of radioactive material to uncontrolled areas. The principal concerns of utilities in implementing segregation programs are lack of regulatory guidance and lack of confidence in clean waste monitoring techniques. These concerns are examined, and it is concluded that regulatory guidance is adequate to permit segregation programs to function; however, conventional contamination monitoring techniques may not provide adequate detection sensitivities. The basic considerations for establishing an effective segregation program are discussed: sorting and segregation, contamination monitoring, and unrestricted release criteria.

Johnson, G.; Junkins, R.; Deeny, K.; et al.

POST-CONSTRUCTION EVALUATION OF INNOVATIVE/ALTERNATIVE TECHNOLOGY
K-4081, WESTON Designers/Consultants, October 1984.

The U.S. Environmental Protection Agency's Innovative and Alternative Technology Research Program has instituted efforts to provide a rational basis for determining wastewater treatment technology performance so that successful technology will become better known and understood, marginal technology improved, and poor technology sent back to the drawing board. The initial efforts of this program are described herein.

The primary objectives of these evaluations are to characterize the performance of a given innovative or alternative technology and to determine which, if any, factors may be contributing to performance inconsistent with the original projection. Six major study areas are utilized to evaluate the technology and identify positive or negative attributes. These areas include design, construction, operation and control (including startup), process monitoring, quality of management/administration, and major equipment performance.

Jones, K. B.; Schavey, T. W.; Schumpert, D. E., Jr.; Snow, A. L.

TRANSPORT, INSTALLATION, AND TESTING OF A TRANSPORTABLE VOLUME REDUCTION AND BITUMEN SOLIDIFICATION SYSTEM
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 551-54, March 1985.

Review of the Transportable Volume Reduction/Radioactive Waste Solidification System (TVR) shows that the fabrication of the system meets the Duke contract specifications and current regulatory requirements and that the system has successfully demonstrated its ability to solidify boric acid, EPRI chemical cleaning solvent, and demineralizer resin wastes in asphalt. Review of disassembly, transport, and reassembly reveals the TVR Systems's flexibility to move in and out of a station without undue impact on station personnel. Modification of the plant for TVR installation is easily accomplished upon conducting a comprehensive review of design considerations; a discussion is given of the actual coordination, design, and construction applied in modifying Duke Power Company's Riverbend Steam Station. Initial results are presented from processing boric acid, chemical cleaning, and demineralizer resin wastes which show that this system is capable of volume reducing and solidifying the wastes.

Jordan, J. M.

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT: AN UPDATE - A LEGISLATOR'S GUIDE
Sandia National Laboratories/DOE, October 1984.

Congress passed the LLRWPA in December 1980 giving states the responsibility for the disposal of commercial low-level radioactive waste generated within their borders. So far, 8 regions have formed and negotiated compacts, and 37 states have ratified their respective compacts.

The purpose of this guide is to assist legislators in their deliberations on LLRW management and siting legislation. It provides information on the evolution of the LLRW issue, status and management practices at the existing sites, options for the state role in LLRW disposal, components of the regional compacts, alternatives to shallow-land burial, and possible approaches to facility siting.

Joy, D. S.; Wilmot, E. L.; et al.

A PRELIMINARY ANALYSIS OF THE COST AND RISK OF TRANSPORTING NUCLEAR WASTE TO POTENTIAL CANDIDATE COMMERCIAL REPOSITORY SITES
SAND83-0867, Sandia National Laboratories, June 1983.

This report documents preliminary cost and risk analyses that were performed in support of the Nuclear Waste Terminal Storage (NWTS) program. The analyses compare the costs and hazards of transporting wastes to each of five regions that contain potential candidate nuclear waste repository sites being considered by the NWTS program. Two fuel-cycle scenarios were analyzed: (1) once-through and (2) reprocessing. Transportation was assumed to be either entirely by truck or entirely by rail for each of the scenarios. The results from the risk analyses include those attributable to nonradiological causes and those attributable to the radioactive character of the wastes being transported.

Katsikis, E. P.

INCINERATION OF LOW-LEVEL RADIOACTIVE WASTE: DESIGN, RECIPE AND ANALYSIS
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. W1 to W4, March 1985.

Design specifications for an incinerator should be such that it is capable of handling low-level radioactive, pathological (usually of large volume), and hazardous waste. Ash that does not contain residual radioactivity and/or hazardous constituents (scintillation media) can be removed to a sanitary landfill. Incineration can reduce the volume of waste and render it nonradioactive and nonhazardous, therefore innocuous to the environment. Proper incinerator design parameters, a recipe for charging the waste, and analytical procedures together will help achieve environmentally sound volume reduction.

Katsikis, E. P.

PART B PERMIT: INCINERATION OF SCINTILLATION VIALS
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. CC1 to CC3, March 1985.

Incineration is the most responsible disposal method for scintillation vials. It reduces the volume and renders the ash nonhazardous when proper design paramenters are followed. Meticulous analyses procedures will ensure that the ash will be delisted under RCRA and that disposal in a sanitary landfill will be permitted.

Although scintillation vials containing ^{14}C and ^{3}H in amounts less than 0.05 μCi/g are not regarded by the Nuclear Regulatory Commission as radioactive waste, the xylene, toluene, and 1,4-dioxane frequently used as the solvent base for scintillation media are listed by the U.S. Environmental Protection Agency as hazardous.

Kawaoka, K. E.; Malloy, M. C.; Dever, G. L.; Weinberger, L. P.

MILITARY HAZARDOUS WASTES: AN OVERVIEW AND ANALYSIS
ATR-81(8376)-1, The Aerospace Corporation, December 1981.

This report presents the results of analyses completed during the period of October 1, 1980, through September 30, 1981, as part of the Aerospace Sponsored Research Program.

This research project examines another vital aspect of military preparedness — the protection of public health and the environment from hazardous wastes generated by the military. The safe and effective management of military hazardous wastes greatly enhances the quality of our lives and strengthens our national security.

The report describes and analyzes the management activities and motivating factors of the military in dealing with its hazardous waste streams. Findings and conclusions in areas of concern are given to provide information that may be of value to the future management of military hazardous wastes.

Kee, C. W.; Croff, A. G.; Blomeke, J. O.

UPDATED PROJECTIONS OF RADIOACTIVE WASTES TO BE GENERATED BY THE U.S. NUCLEAR POWER INDUSTRY
ORNL/TM-5427, Oak Ridge National Laboratory, December 1976.

Eleven types of radioactive wastes to be generated within the fuel cycle operations of the U.S. nuclear power industry are defined; and projections are presented of their annual generation rates, shipping requirements, and accumulated characteristics over the remainder of this century. The power reactor complex is assumed to consist of uranium- and plutonium-fueled LWRs, HTGRs, and LMFBRs, and the installed nuclear electric capacity of the U.S. is taken as 68.1, 252, and 510 GW at the end of calendar years 1980, 1990, and 2000, respectively.

Kempf, C. R.; MacKenzie, D. R.; Bowerman, B. S.; et al.

CHARACTERIZATION OF THE LOW-LEVEL RADIOACTIVE WASTES AND WASTE PACKAGES OF GENERAL ELECTRIC VALLECITOS NUCLEAR CENTER
NUREG/CR-3864, BNL-NUREG-51791, Brookhaven National Laboratory, November 1984.

An evaluation of the low-level wastes and waste packages generated by General Electric Vallecitos Nuclear Center (GEVNC) was made on the basis of 10 CFR Part 61 criteria and on the Technical Position on Waste Form (TP). In addition, a review has been performed of the handling and storage methods used by GEVNC for their transuranic wastes. Several options have been discussed for management of these materials. This evaluation was the result of a study initiated by the U.S. Nuclear Regulatory Commission, in which GEVNC participated.

Based on the evaluation, overall, the waste forms of these packages are expected to maintain their stability, but a few concerns are identified and testing should be performed by GEVNC to demonstrate waste-form stability.

Kessler, J. H.; Dole, L. R.; Robinson, S. M.

RADWASTE GROUTING TECHNOLOGIES APPLICABLE TO HAZÀRDOUS WASTE MANAGEMENT
Proceedings of Second Conference on Municipal, Hazardous, and Coal Wastes Management, CONF-83-12-44, September 1984.

This study establishes the ability of pumpable cement-based grouts developed at the Oak Ridge National Laboratory to fix toxic heavy metals and selected organic compounds in durable monoliths. Simulated hazardous waste streams, containing hazardous inorganic and organic compounds, were solidified in these durable grouts with low leach rates for most of the incorporated toxic compounds. The cements, fly ashes, and other grout components are readily available in bulk, and the tailored, dry-solids blends typically cost less than $0.05 to $0.15 per gallon of waste ($0.01 to $0.04 per liter of waste).

The preliminary cement-based grouts tested in this study retained Cu, As, Pb, Mn, Cd, and toxic organic compounds such that, after a 28-d exposure, the leachate concentrations were below the levels recommended in the U.S. Environmental Protection Agency's EP-TOX tests. Only Cr, Se, and Hg exceeded these limits in the saturated leachates.

Kiang, Y.; Metry, A. A.

HAZARDOUS WASTE PROCESSING TECHNOLOGY
Butterworth Publishers, Ann Arbor, Michigan, 1982.

The purpose of this book is to present the state of the art of treatment (or processing) technologies for hazardous wastes. There are two basic processing technologies, thermal and chemical/physical/biological, and one ultimate disposal method land disposal.

This book is divided into two parts. Part 1 discusses the thermal processing technologies, and Part 2 presents treatment and disposal technologies.

It is the objective of this book to consolidate present state-of-the-art hazardous waste processing technologies into one comprehensive volume. It is hoped that this book will be used as a reference volume for professionals involved with hazardous waste activities.

Kibbey, A. H.; Godbee, H. W.

A CRITICAL REVIEW OF SOLID RADIOACTIVE WASTE PRACTICES AT NUCLEAR POWER PLANTS
ORNL-4924, Oak Ridge National Laboratory, March 1974.

A survey was made of solid radioactive waste practices at light-water-cooled nuclear power plants. Plant operating reports from initial criticality to December 31, 1972, were the main sources of information. A comparison of boiling-water reactors and pressurized-water reactors shows that BWRs consistently shipped a larger total volume of solid radwaste per thermal megawatt-hour than did PWRs. Most operating plants dewater spent bead resins and ship them in drums or casks with disposable liners without binding in a matrix. The trend throughout the industry is toward incorporation of spent resins, filter sludges, filters, and evaporator concentrates in cement or urea formaldehyde using disposable shipping casks or cask liners. However, the 55-gal drum is still widely used as a container for most of these wastes. Design of remotely operated equipment for handling solid radwaste is continually being upgraded, but manual operations have not been eliminated. More adequate reporting of personnel exposures and monitoring methods is needed where manual operations are necessary.

Kibbey, A. H.; Godbee, H. W.

A STATE-OF-THE-ART REPORT ON LOW-LEVEL RADIOACTIVE WASTE TREATMENT
ORNL/TM-7427, Oak Ridge National Laboratory, September 1980.

An attempt is made to identify the main sources of low-level radioactive wastes that are generated in the United States. To place the waste problem in perspective, rough estimates are given of the annual amounts of each generic type of waste (i.e., filter cartridges, filter sludges, and spent ion exchange resins) that is generated. Most of the wet solid wastes arise from the cleanup of gaseous and liquid radioactive streams prior to discharge or recycle. Treatment of the process streams and the secondary wet solid wastes thus generated (e.g., filter cartridges, filter sludges, and spent ion exchange resins) is described for several types of installations. Institutional wet wastes are also described. The dry wastes from all sources have similar physical and chemical characteristics in that they can be classified as compactible, noncompactible, combustible, noncombustible, or combinations thereof. The various treatment options for concentrated or solid wet wastes and for dry wastes are discussed.

Kibbey, A. H.; Godbee, H. W.

THE USE OF FILTRATION TO TREAT RADIOACTIVE LIQUIDS IN
LIGHT-WATER-COOLED NUCLEAR REACTOR POWER PLANTS
NUREG/CR-0141, ORNL/NUREG-41, Oak Ridge National Laboratory,
September 1978.

A survey was made to investigate the current and future use of filtration as a method for treating liquid radioactive streams at light-water-cooled nuclear reactor (LWR) power plants. Pertinent data were obtained by contacting utility companies, nuclear-stream-supply system vendors, architect-engineers, as well as filter manufacturers and vendors. Principal interest was placed upon obtaining operating data on the performance of filters used to treat radioactive liquid streams at LWR plants containing from essentially none up to 2000 ppm (2000 mg/L) of suspended solids. Included in this report are characteristics of the streams filtered at both pressurized-water reactor (PWR) and boiling-water reactor (BWR) plants and the filter requirements for these streams. The many types of filters used, or proposed, for treating radioactive liquids at LWRs are described. To facilitate the collation and interpretation of data, filters are categorized as disposable or reusable in this report. Filters with disposable cartridge elements made of fiber or paper have been the most widely used, especially in PWR plants. Reusable filters with and without precoat (an initial porous cake on the filter element) have also been widely used.

Kibbey, A. H.; Godbee, H. W.; Compere, E. L.

A REVIEW OF SOLID RADIOACTIVE WASTE PRACTICES IN LIGHT-WATER-COOLED NUCLEAR REACTOR POWER PLANTS
NUREG/CR-0144, ORNL/NUREG-43 (Rev. 1 of ORNL-4924), Oak Ridge National Laboratory, October 1978.

This survey was made to update the report published by ORNL in 1974 which reviewed solid radioactive waste practices at light-water-cooled nuclear reactor power plants. The main source of information in both surveys was docket material, including plant annual operating reports, semiannual effluent release and waste disposal reports, etc. The earlier study covered initial criticality to December 31, 1972, while this study covers initial criticality to December 31, 1977. Cement (or cement plus silicate) and urea-formaldehyde resins are the main agents used to solidify radwaste solutions and slurries at LWRs for offsite shipment. However, the use of asphalt and modified vinyl ester resins (or water-extensible polyester) as solidification agents appears near. Among the problem areas reported in radwaste solidification at LWRs were: drum capping, which remains largely a manual operation; poor performance of sonic level indicators, which are noisy and unreliable; oil contamination in the liquid waste streams, which can interfere with the solidification process in some cases (e.g., cement); and free liquid in containers of solidified wastes (especially with the urea-formaldehyde resins).

King, S. H.; Miller, K. L.; Erdman, M. C.

AN OVERVIEW OF AN INSTITUTIONAL INCINERATION PROGRAM
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. Q1 to Q6, March 1985.

Rising costs and the uncertainty of low-level radioactive waste disposal site availability have put a burden on generators to find every means possible of reducing the volumes of such waste. This is especially true at institutions with limited storage capacity. The reclassification of liquid scintillation fluids and animal carcasses containing ^{3}H or ^{14}C have made incineration an attractive alternative to shipment for burial. Research at the Hershey Medical Center has also shown that animal carcasses containing certain gamma-emitting radioisotopes can be incinerated with very high recoverability of the radioisotopes in the ash. Our experience in developing an incineration program, the equipment involved, sampling performed, and cost-effectiveness are reviewed.

Kinoshita, K.; Kakuya, E.

STABILIZING SOLIDIFICATION. I: A METHOD OF IMMOBILIZATION OF RADIOACTIVE WASTE INVOLVING VOLUME REDUCTION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 171-76, March 1985.

Mitsubishi Heavy Industries, Ltd. (MHI), has developed a calciner/incinerator system aiming at an integrated treatment and a large volume reduction of radioactive liquid wastes and combustible solids including spent resins, etc., generated by a nuclear power plant.

It is preferable that the powdery products of calcination and incineration be treated and converted into an immobilized form to ensure safe storage or disposal. MHI has paid attention to utilizing in-waste, glass-network components, such as boron oxide in the calcination products of PWR liquid wastes and silicon oxide and alumina in the incineration ashes, as a method to obtain a greater volume reduction and long-term stability of the wastes. They have confirmed that a stable vitrified form can be produced by melting these wastes at a high temperature.

Furthermore, key parametric data necessary to enlarge the repocessing system have been obtained from a series of vitrification tests using a medium-sized melter, with a prospect of developing the system for practical use.

Kirsch, M.; Melvold, R.; Vrolyk, J.

A HAZARDOUS MATERIALS SPILL WARNING SYSTEM
Rockwell International, December 1978.

The U.S. Environmental Protection Agency has developed a list of materials defined as hazardous substances based on their aquatic toxicity. In addition, certain materials have been designated as "priority pollutants." Often, a spill of toxic material into a moving water stream can occur without the spiller being aware, or without the spiller notifying authorities. Accordingly, a system was needed to detect the presence of hazardous toxic materials in streams and rivers. This need has been filled by providing a spill alarm system, which was designed, fabricated, and tested prior to delivery. It consists of nonselective detection components, which serve to detect all the materials on the designated hazardous materials lists and the priority pollutants. The system was mounted in an automotive trailer and delivered to the Oil and Hazardous Materials Spills Branch in Edison, New Jersey.

Klingler, L. M.

CYCLONE INCINERATOR - OPERATING EXPERIENCE
MLM-3094, Monsanto Research Corporation, September 1983.

The cyclone incinerator, developed at Mound Laboratory in the mid to late 1970s, has proven to be a valuable tool for the volume reduction of the plant's combustible radioactive wastes.

The incinerator has effected a significant reduction in Mound's offsite waste shipping requirements. More than 27 tons (24.5 Mg) of plutonium-contaminated wastes have been incinerated in the system at volume reduction factors of greater than 95%. Moreover, the extreme simplicity of the system in principle, design, components, and operation has resulted in extremely low maintenance cost and real plant cost savings in waste handling and disposal over the past several years.

The cyclone incinerator has more potential plant users than available operating time. In addition to burning dry solids, incineration feasibility has been demonstrated for wastes that present special disposal problems to the plant. These wastes include combustible liquids, scintillation vials, and tritium-contaminated, dry, solid wastes.

Klingler, L. M.

MOUND CYCLONE INCINERATOR VOLUME I. DESCRIPTION AND PERFORMANCE
MLM-MU-81-72-0003, Monsanto Research Corporation, December 1981.

The Mound cyclone incinerator, developed by Monsanto, was designed to fill a need for a simple, reliable incinerator for volume reduction of dry, solid waste contaminated with ^{238}Pu. Although the basic design of the incinerator is for batch burning of solid combustible waste, the incinerator has also been adapted to volume reduction of other waste forms. Specialized waste-feeding equipment enables continuous burning of both solid and liquid waste, including full scintillation vials. Modifications to the incinerator off-gas system enable burning of waste contaminated with isotopes other than ^{238}Pu. This makes the incinerator useful for volume reduction of waste from a variety of nuclear facilities, such as medical, research, power plants, and reprocessing operations. This document presents the design and performance characteristics of the Mound cyclone incinerator for incineration of both solid and liquid wastes. Suggestions are included for adaptation of the incinerator to specialized waste materials, and possible improvements have been included as appropriate.

Knox, R. C.; Canter, L. W.

PROTOCOL FOR AQUIFER-CLEANUP DECISION-MAKING AT MILITARY INSTALLATIONS
University of Oklahoma, circa 1983.

For the past 2 years, personnel at the National Center for Ground Water Research (NCGWR) have been collecting and analyzing information on various aquifer restoration technologies and previous application of ground-water pollution cleanup measures. One result of this study is the development of a protocol or structured approach for selecting an optimum aquifer restoration strategy. With minor modifications, this protocol can be applied to Department of Defense installations. The protocol represents an invaluable aid for conducting the first three phases of an Installation Restoration Program. The remainder of this paper outlines the major steps of the protocol.

Koch Process Systems, Inc.

VR-SYSTEM 350
Promotional Brochure, Koch Process Systems, Inc., circa 1985.

The developing need for the volume reduction of radioactive waste is well known in the nuclear industry. Volume reduction, as an improved radwaste management technique, is justified primarily by the increased cost of disposal and tightening regulatory requirements. Koch Process Systems, Inc., has developed an incineration system, the VR-System 350, that makes the volume reduction of dry active waste, contaminated waste oil, evaporator concentrates, and low-level ion exchange resins economically attractive. The VR-System 350 is based on an incineration process developed at Los Alamos National Laboratory for transuranic-contaminated wastes. Working under a Department of Energy contract to commercialize the technology, Koch Process Systems has modified the Los Alamos design to make it suitable for installation at a nuclear power plant, or other nuclear fuel cycle facility, to incinerate fission- and corrosion-product-contaminated wastes. The VR-System 350 has been designed to be easily maintained, flexible with respect to layout considerations for both new and existing sites, compatible with existing drumming and solidification processes, reliable, and economically attractive.

Koerner, R. M.; Lord, A. E., Jr.

NONDESTRUCTIVE TESTING METHODS OF DETECTING BURIED WASTES
Chemical Engineering Progress, Vol. 81, No. 3, pp. 39-42, March 1985.

Nondestructive Testing Methods (NDT) is a new approach to many hazardous materials waste problems. The authors' field and literature studies show the following results:

1. For dike stability, acoustic emission has proven to be an excellent technique.
2. Subsurface and depth tracing are the most difficult of all problems mentioned.
3. Surface container corrosion is a problem, but a combination of ultrasonics and eddy currents may be a definite help.
4. Buried container location is a "natural" for microwave techniques.
5. For buried pipe leaks, acoustic emission has been shown to be a definite help.

Komai, R. (Project Manager)

APPLICATION OF BIOTECHNOLOGY TO PCB DISPOSAL PROBLEMS
EPRI CS-3807, Leland D. Attaway and Associates, American Technology Management Consultants, May 1985.

Disposal of polychlorinated biphenyl (PCB) wastes presents an immense problem for utilities because of the compound's persistence in the environment. This assessment of biotechnologies suggests that new approaches to PCB biodegradation may be feasible but that several years of R&D work remain to be done.

Some chlorinated biphenyl compounds found in electrical equipment are biodegradable, but the bulk of the utility PCB inventory is composed of highly chlorinated compounds, which biodegrade very slowly. Thus, the problem is one of finding ways to enhance the biodegradation rate. It does appear that biodegradation of PCB is feasible, given further R&D. This report provides an extensive assessment of the state of the art of biotechnology and and an excellent summary of its underlying concepts. It will serve as a useful primer for utility personnel and others interested in applying the methods of biotechnolgoy to PCB disposal.

Komai, R. (Project Manager)

CHARACTERIZATION OF UTILITY LOW-VOLUME WASTES
EPRI CS-3737, Radian Corporation, May 1985.

Potential EPA regulations covering hazardous-waste disposal under the Resource Conservation and Recovery Act could impact a large segment of industry. Utilities would be significantly affected if their low-volume wastes were classified as hazardous. However, tests run on samples of such wastes suggest that most would meet EPA nonhazardous standards.

Although only a small number of waste samples were characterized, it is clear that - except for boiler waterside chemical-cleaning wastes - the tested waste samples do not approach the toxicity levels set by EPA standards. Some wastes that meet EPA standards, however, may fall into hazardous classes in states that have set lower toxicity limits. Still, if the proposed federal standards are used, codisposal should continue to be an acceptable disposal method for most low-volume wastes. For utilities, it also remains the most economical. Related work, discussed in EPRI report CS-2126, examines the compatibilty of wastes with landfill liner materials. Further work under this project will evaluate whether the chemistry of codisposed materials differs from that of unmixed wastes.

Kornblith, L., Jr.; Giuffre, M.; Naughton, M.

SEGREGATION OF LOW-LEVEL, DRY, ACTIVE WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 401-4, March 1985.

This paper describes an EPRI-sponsored project to provide the technical basis for exempting some extremely lightly contaminated radioactive trash from the disposal requirements of 10 CFR 61. The analysis shows that TVA's Sequoyah Plant could save more than $250,000 per year if the NRC would allow them to dispose of 200 mCi/year of trash with a specific activity of less than 2 nCi/g in a nearby landfill. Only the driver of the trash hauler would receive a dose, 14 mrem/year, that was a substantial fraction of the natural variation in background radiation. Landfill workers would receive a yearly dose of less than 0.6 mrem/year; no member of the general populace would receive a measurable dose. The paper also discusses the development of procedures to ensure that the trash limits are met. This study will form the technical basis for TVA's request to NRC to grant the exemption from the 10 CFR 61 disposal requirements.

Koshiba, Y.; Nakatani, T.; Kuribayashi, H.; Kurosaka, N.

OPERATIONAL EXPERIENCES OF NONPRECOATED TYPE FILTERS (SUPER-FINE FILTER) IN PWR AND BWR NUCLEAR POWER PLANTS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 579-83, March 1985.

Precoated- and cartridge-type filters which are conventionally used in Japanese LWR nuclear power plants still have the disadvantage of generating a large amount of spent filter media as secondary waste. In addition to that, they are insufficient in separation performance and require frequent maintenance resulting in radiation exposure to personnel. In order to resolve these problems, the Super-Fine Filter (SF filter) has been successfully developed and applied at many Japanese LWR nuclear power plants. This paper describes the results of the R&D work and operational experiences of the SF filter at nuclear power stations.

Kowalchuk, M.

BIODENITRIFICATION OF GASEOUS DIFFUSION PLANT AQUEOUS WASTES: FLUID-BED REACTOR
GAT-2011, Goodyear Atomic Corporation, January 1982.

Decontamination and uranium recovery operations at Portsmouth generate raffinates which contain nitrate. Nitrate discharges are now within EPA limits. However, more stringent limits go into effect on October 2, 1982. These limits cannot be met by present operating methods without seriously restricting decontamination and recovery operations. A biodenitrification process will therefore be used at Portsmouth to reduce the nitrate concentration to acceptable levels. Pilot-plant studies using a fluid-bed reactor were carried out at ORNL. Process operating parameters were characterized, and design criteria for the full-scale facility, which is to be built at Portsmouth, were devised. When operations were completed, the pilot plant, equipped with a 20-in. (50-cm) bioreactor, was shipped to Portsmouth. It will be installed during FY 1982 and will be operated until the full-scale facility is built. It will allow GAT to meet EPA limits and will accommodate 9,000 L of raffinate per month. The projected post-CIP/CUP raffinate generation rate is 15,000 L per month. Recovery operations will be limited to some extent until the full-scale biodenitrification facility is built.

Krause, C.

SILVER RECOVERY FORM ORNL WASTES
Review, Oak Ridge National Laboratory, Vol. 15, No. 4, pp. 2-7, Fall 1984.

Nearly 113,500 L (30,000 gal) of waste liquids, generated by ORNL's photographic and photocopying equipment, produced each year at ORNL contain silver, which had a market value of $10 per troy ounce ($0.32/g) in 1981 and as high as $40 per troy ounce ($1.28/g) in 1979. The precious metal has been recovered electrolytically from ORNL waste liquids since 1968, but interest in recovering a higher percentage of the silver content has been kindled recently because of new environmental regulations forbidding discharges of high concentrations of toxic metals. A small plant for treating 95-L (25-gal) batches, using the hypochlorite-hydrazine and sodium dithionite processes developed by Franz Posey and Al Palko of the Chemistry Division, was assembled in January 1984. Preliminary results indicate that all but 0.2 to 0.5 mg/L (0.5 ppm) of silver can be recovered from photoreproduction wastes in the new pilot plant. Discharge into the sanitary sewer system dilutes the remaining silver concentration well below EPA and Tennessee limits. Use of the new silver recovery process will save ORNL about $80,000 in disposal and shipping costs. At current values, recovered silver could be worth up to $25,000 annually.

Lafornara, J. P.; Frank, U.; and Wilder, I.

ENVIRONMENTAL EMERGENCY RESPONSE UNIT (EERU) OPERATIONS AT THE HOPEWELL VIRGINIA KEPONE INCIDENT
Environmental Protection Agency, pp. 236-239, circa 1976.

The incident described in this paper involved the contamination of the Hopewell, Virginia, area by Kepone produced by the Life Sciences Products plant in that city. In addition to being present in gross amounts at the plant, Kepone could be found in alarmingly high concentrations in the city sewer system, in nearby residences and businesses, in the clothing and homes of the plant's employees, and in the waters and aquatic species of the James River.

A decision was made that the plant should be decontaminated and dismantled. During these operations, a great amount of water was sprayed to retard the spread of Kepone dust; this effluent and rainwater runoff from the site were collected in three concrete holding basins. The contents of these basins were periodically pumped into railroad tank cars for temporary storage. The decision was made to bring in the Mobile Physical-Chemical Treatment System, its support equipment, and the Emergency Response Unit (EERU) for the treatment of the stored water. This paper documents EERU's on-site activities.

Lafornara, J. P; Freestone, F. J.; Polito, M.

SPILL CLEANUP AT A DEFUNCT INDUSTRIAL WASTE DISPOSAL SITE
Environmental Protection Agency, pp. 152-155, 1976.

Pollution Abatement Services (PAS), a financially troubled company, was responsible for three oil spills into Lake Ontario during 1976. The Mobile Physical-Chemical Treatment System was deployed. The following cleanup actions were required: (1) removal of the 10,000 leaking and intact drums of various waste chemicals, many of which were uncharacterized; (2) removal of all oil stored on the site in above- and below-ground tanks; and (3) the removal and proper disposal of the contents [1.4 million gal. (5300 m^3)] of all lagoons.

Lamp'l, H. J.; Masses, T.; Freestone, F. J.

ASSESSMENT AND CONTROL OF A GROUND- AND SURFACE-WATER CONTAMINATION INCIDENT, HAVERFORD, PENNSYLVANIA, NOVEMBER-DECEMBER 1976.
Environmental Protection Agency, pp. 145-147, November 1977.

Several residents discovered a foul-smelling, oily substance seeping into Naylor's Run, which empties into a freshwater tidal marsh at its confluence with the Delaware River. This marsh is the last remaining freshwater tidal marsh in Pennsylvania. The oily substance was toxic, and no life was present in the stream where the oil was concentrated. The fluid was found to be free of emulsified oil, PCP, and suspended solids.

The treatment of the mixture of solids, oil, PCP, and water was quite successful using the Mobile Physical-Chemical Treatment System with the analytical support provided by the Mobile Spills Laboratory.

As of November 1977, the pollution problem was not solved, only specified. There remains a large volume of contaminated soil and groundwater; leaching of contaminants may continue for years. In general, there is very little that can be done technically other than recover and treat the leachate.

Larson, D. E.; Buelt, J. L.; Heath, W. O.; Partain, W. L.

ASSESSMENT OF POWER REACTOR WASTE IMMOBILIZATION BY VITRIFICATION
EPRI NP-3225, August 1983.

A study was performed to determine the technical and economic viability of applying vitrification to volume reduction and immobilization of nuclear power-plant radioactive waste (radwaste). Vitrification technology has been extensively developed both in the United States and abroad for immobilization of high-level radioactive waste. A conceptual design of a facility to vitrify light-water reactor radwaste (except noncompactible/noncombustible wastes) was developed. Technical, economic, and safety evaluations were performed for waste vitrification. Technical and economic comparisons were made with available technologies for radwaste volume reduction and immobilization. It was concluded that vitrification is a viable and competitively attractive approach; however, some additional process verification should be conducted prior to plant application.

Lawroski, H.; Potter, J. R.; Woodle, A. S.

FEASIBILITY OF APPLICATIONS OF MICROWAVE TECHNOLOGY FOR NUCLEAR POWER PLANT RADIOACTIVE WASTES
EPRI NP-2334, April 1982.

A study on the feasibility of using microwave energy for drying of radioactive wastes is presented. A review of process techniques now in use and proposed is also included, and the basics of microwave heating is discussed. A review of tests performed includes:

1. scoping testing, and

2. laboratory testing in batch and continuous-feed modes.

Finally, a preliminary design is presented for both a batch system and a continuous-feed system for processing a minimum of 5000 ft^3 (140 m^3) of ion exchange resin beads per year.

Leduc, R. J.

OPERATING EXPERIENCE WITH A HIGH-FORCE COMPACTOR
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. H1 to H9, March 1985.

Dry, activated waste (DAW) produced at nuclear power plants accounts for the largest fraction of the radioactive waste volume generated and shipped for burial. The application of advanced volume reduction techniques to DAW is now even more important as the time for potentially significant reductions in burial space allocation approaches. This paper discusses the design features, operating performance, and economic advantages of the Westinghouse Hittman mobile high-force compaction service. COMPACT I is a technology that can be applied today without the corresponding capital expenditures and licensing efforts required of incineration.

Lewandowski, K. E.

A SAVANNAH RIVER PLANT INCINERATOR DEMONSTRATION
DP-MS-83-90, E. I. du Pont de Nemours & Co., 1983.

A full-scale incineration process was demonstrated at the Savannah River Laboratory (SRL) using nonradioactive wastes. From October 1981 through September 1982, 15,700 kg of solid waste and 5.7 m^3 of solvent were incinerated. Emissions of off-gas components (NO_x, SO_2, CO, and particulates) were well below South Carolina state standards. Volume reductions of 20:1 for solid waste and 7:1 for Purex solvent/lime slurry were achieved.

The process has been relocated and upgraded by the Savannah River Plant to accept low-level, beta-gamma combustibles. During a 2-year demonstration, the facility will incinerate slightly radioactive (<1.7 mCi/m^3) solvent and suspect level (<1 mR/h at 2.5 cm) solid wastes.

Leventhal, L.; et al.

CHEMICAL HAZARDS FROM DECONTAMINATION SOLUTIONS IN LOW-LEVEL WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 227-32, March 1985.

Recent regulations are focusing more attention on the nonradioactive matrix materials associated with radioactive wastes. Decontamination of operating facilities is becoming a more significant source of low-level waste. This study reviewed the chemical and biological hazards of over 50 decontamination processes. Seventeen of the most prominent hard and soft decontamination processes were examined in detail. The chemical and biological hazards of these seventeen are presented in this paper. These hazards influence the choice of radwaste processing and packaging operations and methods. Federal, state, and local regulations further impact on operations and waste disposal. Hazards to personnel, in-plant and off-site, resulting from the decontamination cycle are evaluated.

Lin, K. H.

USE OF ION EXCHANGE FOR THE TREATMENT OF LIQUIDS IN NUCLEAR POWER PLANTS
ORNL-4792, Oak Ridge National Laboratory, December 1973.

A study was made to investigate the current and future uses of ion exchange (demineralization) as a method for treating liquid radioactive streams at nuclear power plants. Pertinent data were obtained by contacting utility companies, nuclear-steam-supply system vendors, selected AEC-operated facilities, as well as ion exchange resin and equipment manufacturers. Principal emphasis was placed on obtaining data concerning the decontamination of aqueous solutions characterized by levels of radioactivity that range from 0.1 μCi/mL to 1 Ci/mL. Included in this report is a list of average F values that can be obtained for various ion exchange systems and various groups of radionuclides if good engineering practice is used in the design and operation of these systems. These values are based on ion exchange fundamentals, literature data, laboratory experiments, and plant operating experience. They represent time-averaging values expected under normal operating conditions rather than maximum values attainable under optimum conditions.

Loehr, R. C. (Chairman), et al.

REDUCING HAZARDOUS WASTE GENERATION
National Academy Press, Washington, D.C., 1985.

This report examines key institutional, or nontechnical, factors that affect the generation of hazardous waste by industry. It provides a framework for evaluating public policies, both regulatory and nonregulatory, to reduce the generation of hazardous wastes. In undertaking its task, the committee recognized that the report itself was not expected to provide detailed solutions; rather, it was expected to provide a foundation upon which improved public policies for hazardous waste management could be built. The report's underlying premise is that waste reduction should be an integral component of any national waste management strategy. For the purposes of this report, "waste reduction" refers not only to in-plant process modifications that reduce the volume or degree of hazard of hazardous waste generated, but also to reuse and recycling practices. This report is one of the first to deal with nontechnical factors affecting the generation of industrial hazardous waste. Because little study has been devoted to this topic, committee members have relied on the presentations, reports, workshops, discussions, and ultimately their own experience and judgment in formulating their recommendations.

Loughead, J. S. C.

THE DOE NATIONAL LOW-LEVEL WASTE MANAGEMENT PROGRAM - AN OVERVIEW
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. X1 to X7, March 1985.

This program presents an overview of the National Low-Level Waste Management Program, including both the objectives and the initiatives toward these objectives. For clarity, the program is considered within the context of defense program activities, and nuclear energy activities.

Lysen, P.

LICENSING EXPERIENCE WITH LARGE INCINERATORS
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. EE1, March 1985.

The NRC's Office of Nuclear Material Safety and Safeguards (NMSS) has under active review two license applications for operation of large incineration systems for volume reduction of low-level radioactive waste. One application is by Battelle Columbus Laboratories for a demonstration program using the German Draftanlagen incinerator design; the other is by Babcock & Wilcox for a volume reduction facility using the Aerojet Energy Conversion Company's mobile incinerator system. Additionally, NMSS is assisting our Office of State Programs, which was asked by the State of North Carolina to review U.S. Ecology's application for a license to operate an incinerator to be built by Associated Technologies.

While no conclusions have yet been reached regarding the acceptability of the applications, the main issues that must be considered have become clear. First and foremost is that of effluents from routine operation of a facility--their control, measurement, and impact. Other issues include occupational exposure from routine operations and maintenance, waste/product management, and impacts from postulated accidents and transportation.

Mackie, J. A.; Nesen, K.

THE ALTERNATIVES
Chemical Engineering, August 6, 1984.

As recently as 10 years ago, few industries were concerned about the generation and disposal of their solid wastes, even those that were thought of as toxic or hazardous. Today, however, the situation is quite different.

This article: (1) reviews several hazardous waste regulations and their impacts; (2) outlines the major technical and nontechnical issues that must be adressed; (3) describes a number of physical, chemical, biological, thermal, and fixation and encapsulation technologies that are alternatives to direct land disposal; and (4) discusses some of the technical, economic and sociopolitical obstacles to implementing those alternatives.

Mallory, C. W.; DiSibio, R.

A MODULARIZED SYSTEM FOR DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 155-59, March 1985.

A modularized system for the disposal of low-level radioactive waste is presented that attempts to overcome the past problems with shallow-land burial and gain public acceptance. All waste received at the disposal site is packaged into reinforced concrete modules which are filled with grout, covered, and sealed. The hexagonal shape modules allow a protective cover constructed of natural materials to be installed, and the disposal units are decommissioned as they are filled. The modules are designed to be recoverable in the event remedial action is necessary. The cost of disposal with a facility of this type is comparable to current prices of shallow-land burial facilities. The system is intended to address the needs of generators, regulators, communities, elected officials, licensees, and future generations.

Ma, M. S.; Watts, R. J.; Jorgensen, J. R.

NEW YORK STATE INTERIM WASTE MANAGEMENT COST EVALUATION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 27-33, March 1985.

The purpose of this study is to investigate and quantify the comparative costs associated with including or excluding Class A utility wastes at a centralized interim waste management facility in New York State. The objective of the study is to assess the unit costs and total statewide costs associated with two distinct scenarios: (1) the case where nonutility Class A LLRW is received, incinerated, and stored at the centralized interim facility, and utility Class A wastes are held without incineration at respective nuclear power plant interim onsite facilities without incineration; and (2) the alternative case where both utility and nonutility Class A wastes are accepted, incinerated, and stored at the centralized facility.

Unit costs to waste generators are estimated for each of the two cases described. This is followed by an estimation of the statewide cost impact to the public. The cost impact represents the cost differential resulting from the exclusion of utility Class A waste from the centralized NYS interim waste management facility.

Martin Marietta Energy Systems, Inc.

TSCA OAK RIDGE PCB INCINERATION FACILITY-PROCUREMENT SPECIFICATION FOR THE FEED, INCINERATOR AND OFF-GAS TREATMENT SYSTEMS
Martin Marietta Energy Systems, Inc., August 30, 1984.

This specification covers the "turnkey" requirements for the design, procurement, fabrication, installation or construction, start-up, and performance testing of an integrated facility for incineration and off-gas treatment of hazardous organic waste materials, including polychlorinated biphenyls (PCBs) which may be contaminated with low-assay uranium (<1% ^{235}U).

Maughan, R.

LOW-LEVEL WASTE INCINERATION AT THE IDAHO NATIONAL ENGINEERING LABORATORY
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. K1, March 1985.

A facility for the incineration of low-level, beta/gamma-contaminated combustible waste has been constructed at the Waste Experimental Reduction Facility (WERF) at the Idaho National Engineering Laboratory (INEL). The incineration facility was established to: (1) reduce the volume of currently generated contaminated combustible waste being disposed at the INEL's radioactive waste disposal site and thereby prolong the site's useful life, and (2) develop waste processing technology by providing a facility where full-size processes and equipment can be demonstrated and proven during production-scale operations.

Cold systems testing has been completed, and contaminated operations began in September 1984. Currently, the facility is processing waste packaged in 2 x 2 x 2 ft (0.6 x 0.6 x 0.6 m) cardboard boxes and measuring <10 mR/h at contact.

McClintick, B. R.

PCB TRANSFORMERS: REPLACE OR RETROFILL?
Hazardous Materials and Waste Management Magazine, pp. 30-34, October 1984.

Electrical transformers with high PCB concentrations cannot be used in operations where there is risk of contact with food and feed after October 1, 1985. In some cities, public sensitivity to the health and environmental effects of PCBs creates a different type of problem. In case of fires or explosions that involve PCB transformers, owners are potential targets for extensive liability suits, public criticism, restrictive local or state legislation, and heavy cleanup costs. The transformer owner can do either of two things to avoid such difficulites: (1) replace the transformers with approved units, or (2) replace the liquid coolant in the transformer. The best solution requires a careful analysis of economic, technical, and risk factors.

For either option, silicone dielectric coolants are a popular choice. They offer a way to minimize both fire and environmental hazards while maintaining the electrical integrity of liquid transformers.

McGough, M. S.

LETTER TO MR. ED JENNRICH
Promotional Letter, Quadrex HPS, Inc., December 1984.

Equipment and decontamination services provided by Quadrex HPS, Inc., are as follows:

1. Radkleen DC dry cleaning system using Freon,
2. Radkleen TDU tool decontamination system using high-pressure Freon,
3. Radkleen satellite cleaning chambers,
4. water-based respirator decontamination systems,
5. electropolishing systems,
6. vibratory finishing systems,
7. recycle center in Oak Ridge, Tennessee,
8. mobile decontamination vans, and
9. low-oxidation metal-ion process.

McGowin, C. R.

MUNICIPAL SOLID WASTE AS A UTILITY FUEL
Chemical Engineering Progress, Vol. 81, No. 3, pp. 57-63, March 1985.

Energy recovery from municipal solid waste (MSW) is being considered by many communities both as an alternative energy source and as a method of waste disposal. In some U.S. cities, landfill disposal space is disappearing, and the combination of waste disposal and energy recovery is an attractive alternative. A recent survey published by the U.S. Conference of Mayors lists more than 120 operating or committed refuse-energy-recovery projects in the United States.

Electric utilities provide an important function in most community energy recovery projects as customers for fuel, steam, or electricity and, in some cases, as operators of refuse-to-energy conversion facilities.

McGrath, R. N.; Volodzko, M.; Naughton, M. D.

OPERATING EXPERIENCE OF A MOBILE WASTE SHREDDING SYSTEM
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 181-86, March 1985.

The disposal of low-level radioactive waste (LLRW) in the United States has become a significant problem challenging the commercial nuclear power industry. Over the past several years, there have been major changes in various aspects of LLRW generation, shipment, and disposal. These changes have been characterized by legislative uncertainty, more stringent regulations, and increasing restrictions on shipments imposed by disposal sites and regulatory requirements. These effects have strongly impacted the current nationwide disposal system for LLRW, and the industry is faced with higher shipping and disposal costs, on-site storage and soon, in come cases, no availability for LLRW disposal sites.

The industry is responding to this problem by scrutinizing and improving the way in which LLRW is managed on-site. Conventional and advanced volume reduction (VR) radwaste treatment systems are receiving more attention, with both short- and long-term solutions being considered.

Meile, L. J.; Johnson, A. J.

WASTE GENERATION REDUCTION - NITRATES - FY 1982 STATUS REPORT
RFP-3465, Rockwell International, January 1984.

As a result of bench-scale feasibilty tests, it was demonstrated that nitrate-nitrite-containing waste can be dstroyed with only low (<400 ppm) NO_x emissions. In order to achieve that result, the melt temperature was >970°C and preferably at 1000°C. The NO_x emissions were independent of the gas used to transport the salt waste. The above results indicate that further bench-scale tests are warranted. However, before conducting additional tests, difficulties associated with the erratic feed must be resolved. Part of the problem was associated with the fact that the feedstock tended to melt while passing through the downcomer. The sticky melting particulates caused a deposit buildup on the wall; the deposit eventually dropped into the melt. This effect would be much less apt to occur in a system modified with either a side-entry nozzle or an improved downcomer.

Further tests are warranted to improve carbon and nitrogen balances and to acquire data pertinent to larger-scale operation.

Meile, L. J.; Johnson, A. J.

WASTE GENERATION REDUCTION — NITRATES — FY 1983 STATUS REPORT
RFP-3619, Rockwell International, February 16, 1984.

A study was initiated at the Rocky Flats Plant to develop and demonstrate technology to eliminate nitrates in low-level waste streams without the generation of objectionable oxides of nitrogen. Two thermal proceses were evaluated, and both produced denitrification efficiencies in excess of 95%. Significant progress in chemical methods of denitrification of aqueous nitrate wastes was achieved through the use of chemical reaction agents and catalysts. Denitrification efficiencies ranging from 65 to 85% were recorded during the aqueous tests. A thermodynamics study indicated that favorable potentials exist for chemical denitrification reactions to proceed to completion. The results of the microwave and ultrasonic work were inconclusive because of the preliminary nature of the tests.

A peer review was conducted to obtain input on the progress and direction of the program from actual producers of nitrate waste. The consensus appeared to favor a chemical denitrification method over a high-temperature thermal process if such were feasible. Concurrent development of both methods was suggested.

Meile, L. J.; Meyer, F. G.; Johnson, A. J.; Ziegler, D. L.

ROCKY FLATS PLANT FLUIDIZED-BED INCINERATOR
RFP-3249, Rockwell International, March 1982.

Laboratory- and pilot-scale testing of a fluidized-bed incineration process for radioactive wastes led to the installation of an 82-kg/h demonstration unit at Rocky Flats Plant in 1978. Design philosophy and criteria were formulated to fulfill the needs and objectives of an improved radwaste incineration system. Unique process concepts include low temperature (550°C), flameless, fluidized-bed combustion, and catalytic afterburning; in situ neutralization of acid gases; and dry off-gas cleanup. Detailed descriptions of the process and equipment are presented along with a summary of the equipment and process performance during a 2.5 year operational testing period. Equipment modifications made during the test period are described. Operating personnel requirements for solid waste burning are shown to be greater than those required for liquid waste incineration; differences are discussed. Process utility and raw materials consumption rates for full-capacity operation are presented and explained. Improvements in equipment and operating procedures are recommended for any future installations. Process flow diagrams, an area floor plan, a process control system schematic, and equipment sketches are included.

Michalovic, J. G.; Akers, C. K.; Baier, R. E.; Pilie, R. J.

MULTIPURPOSE GELLING AGENT AND ITS APPLICATION TO SPILLED HAZARDOUS MATERIALS
EPA-600/2-77-151, Calspan Corporation, August 1977.

The blend known as the Multipurpose Gelling Agent (MGA) has been optimized to obtain a balanced formulation that will effectively gel and immobilize most spilled hazardous liquids within minutes. The current formulation, consisting of four powdered polymers and one inorganic powder, has the ability to immobilize spilled liquids with the least amount of material in the shortest period of time, but evaluations of alternative materials are still in progress. In field-testing the blend, it was determined that air conveyance modes of dispersal could be employed, but with high losses due to the effects of wind on the powdered form. Three compressed and granulated forms of the gelling agent were then developed which are clearly superior to the original powdery blend for delivery to liquid spill targets. Various off-the-shelf dry solid dispersion devices were evaluated, and the most promising systems were field-tested on simulated and actual spill targets, both in pools and in linear ditches. The results show that MGA is potentially cost-effective and efficient.

Michlink, D. L.; Marshall, D. L.; Turner, V.; et al.

THE FEASIBILITY OF SPENT RESINS INCINERATION AT NUCLEAR POWER PLANTS
Waste Management '83, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 439-43, March 1983.

Due to the chemical nature and potentially high curie content of spent ion exchange resins, the nuclear industry has moved with caution in the incineration of the spent resins and solidification of the resultant ash. In November 1981, Aerojet finished an extensive ion exchange resin incineration test program which was closely monitored by TVA. The data from the test program provided insight into the resin incineration process and resultant product. The data verified that incineration of spent ion exchange resins is a feasible means of reducing the overall volume of radwaste requiring disposal. However, care must be exercised in the basic process used for incineration of resins, the cleanup of the resultant off-gas, and the disposal of the scrub solution generated by the off-gas cleanup system. This paper discusses in further detail the subject of spent resin incineration.

Miller, A. D.; Best, W. T.

PWR WASTE-GAS SYSTEM ANALYSIS
EPRI-NP-3476, Impell Corporation, May 1984.

This report presents the results of the waste-gas systems study in three operating pressurized water reactors, with particular emphasis on the oxygen concentration in the waste-gas decay tanks. This report provides a description of each waste-gas system from which the samples were taken, a description of the analytical procedures utilized, and the results obtained from each. Samples and analysis were acquired from three operating reactors over a period of 7 months.

The primary purpose of this effort was to gather sufficient operating data to characterize the performance and limitations of PWR Waste-Gas Systems. In addition, problems associated with these systems, both procedural and analytical, were indentified and corrected.

Miller, A. D.; Turney, J. H.; Leventhal, L.

DISPOSAL OF RADIOACTIVE DECONTAMINATION SOLUTION WASTES
EPRI-NP-3655, Impell Corporation, September 1984.

Recent regulations are focusing more attention on the nonradioactive aspects of radioactive waste. Decontamination of operating facilities as a precursor to decommissioning is becoming a more significant source of low-level waste. This study examined the chemical and biological hazards of over 50 decontamination processes. Seventeen of the most prominant processes were examined in detail. The chemical and biological hazards of those seventeen are presented in this report. Waste processing options have been examined, and the most viable options are discussed in this report.

Minnesota Waste Management Board

HAZARDOUS WASTE MANAGEMENT PLAN
Minnesota Waste Management Board, December 1983.

This report has been prepared by the Minnesota Waste Management Board (WMB) as part of its responsibility to prepare a Final Hazardous Waste Management Report, a Draft Hazardous Waste Management Plan, and a Draft Certificate of Need for Disposal Facilities for the Legislative Commission on Waste Management by November 1983. This report provides background information on the current status of hazardous waste generation and management in Minnesota, as well as an analysis of technical and management options for the future. The Draft Plan and Certificate of Need are decision documents that record the WMB's conclusions and recommendations on these issues. The Draft Plan and Certificate of Need will be the subjects of a public hearing in January 1984, and revised drafts will be available in February for use by the Minnesota Legislature during the 1984 session.

MITRE Corporation

QUALIFICATIONS TO CONDUCT HUMAN HEALTH HAZARD ASSESSMENT
Promotional Brochure, The MITRE Corporation, July 13, 1984.

The MITRE Corporation, through its Energy, Resource and Environmental Systems Division, has established a center of expertise in environmental chemistry and biology capable of providing high-quality technical support to Federal, state, and local government agencies responsible for research and regulatory programs in the area of toxic substances. Assembled at MITRE are biologists, biochemists, chemists, toxicologists, chemical engineers, and economists with the skills, background, and training required for performance of a wide variety of studies relating to all aspects of toxic hazard assessment and control. Such studies include: (1) assessment of the manufacture, processing, use, and disposal of potentially hazardous chemicals; (2) environmental transport and fate; (3) human and environmenal exposure; (4) possible adverse health effects; (5) risks of adverse health effects; (6) applicable control technology and personal protection devices; and (7) the costs and benefits of environmental regulations. These studies have been performed on a wide variety of chemicals for numerous clients. Attachment 2 of the qualification summary is a list of selected project descriptions.

Mitsubishi Heavy Industries, Ltd.

MITSUBISHI TOTAL NUCLEAR WASTE MANAGEMENT
Promotional Brochure, Mitsubishi Heavy Industries, Ltd., 1984.

Mitsubishi Radwaste Management:
Integrated radwaste management system; volume reduction, stabilization, transportation, storage, and disposal.

Mitsubishi Spent Fuel Management:
Integrated spent fuel management system; cask, transportation, storage, and reprocessing.

Miyal, H.; et al.

JOINT UNDERTAKING OF A BITUMINIZATION PLANT FOR LOW- AND MEDIUM-ACTIVE LIQUID WASTE AT TOKAI-MURA, JAPAN
Fuel Reprocessing and Waste Management, pp. 2-177 to 2-187, August 1984.

Power Reactor Nuclear Fuel Development Corporation (PNC) has built a bituminization plant for the insolubilization of low- and intermediate-level liquid radioactive waste originating from the nuclear fuel reprocessing operations at Tokai-Mura. The insolubilization process consists of a chemical pretreatment by coprecipitation and pH adjustment, followed by an evaporation and incorporation into liquified bitumen in a four-screw extruder-evaporator. The bituminized product is poured into drums which are transferred to engineered storage cells after solidification and cooling.

M. M. Dillon, Ltd.

DESTRUCTION TECHNOLOGIES FOR POLYCHLORINATED BIPHENYLS (PCBs)
EPS-3-EC-83-1, M. M. Dillon, Ltd., Canada, July 1983.

The need to find an acceptable solution is growing because PCBs and PCB-containing wastes continue to be stockpiled in ever-increasing quantities in various locations throughout Canada. A number of significant spills have occurred in Canada. Although two destruction facilities (rotary kilns) and a number of treatment processes are now operating in the United States, the border can be closed at any time to the entry of PCBs and other material. Import/export of these materials is always at the discretion of the two countries.

Data concerning methods for the destruction of PCBs are presented in this report. The information on the technologies was gathered from numerous sources to provide background information for future assessment or to assist in a selection process. The technologies reviewed fall into four categories: (1) conventional incineration, (2) novel incineration, (3) chemical processes and (4) physical/chemical processes.

Moore, T.

DECOMMISSIONING OF NUCLEAR POWER PLANTS
EPRI Journal, Vol.10, No. 6, pp. 14-21, July/August 1985.

NRC defines decommissioning as the safe removal of a nuclear facility from service and a reduction of the residual radioactivity to a level permitting release of the property to unrestricted use and termination of the plant license. The commission's proposed (or extant) decommissioning rules, however, do not specify what levels of residual radioactivity will be permissible; these are to be defined under a separate rule making now under way in conjunction with EPA. While many people commonly assume that decommissioning is intended to restore a plant site to its original "green field" condition, EPRI believes that safe storage, or mothballing, of a facility may be a utility's preference unless it has only a fixed-term lease for the site land. There are three distinct approaches to decommissioning, ranging from immediate decontamination and full dismantlement (DECON) to safe storage and deferred dismantlement (SAFSTOR) - also known as mothballing - and entombment (ENTOMB). Even though very little experience in decommissioning exists, most of the operations involved have been done for other reasons at one time or another. The technology for decommissioning nuclear plants is available now.

Moore, T.

THE GREAT STATE OF UNCERTAIN LOW-LEVEL WASTE DISPOSAL
EPRI Journal, Vol. 10, No. 2, pp. 21-29, March 1985.

On January 1, 1986, each of the 50 states must assume responsibility for waste generation within its borders, and states now operating low-level radwaste disposal sites may begin refusing to accept the nuclear waste of others. The law responsible for this, the Low-Level Radioactive Waste Policy Act of 1980, was designed to encourage states to form regional compacts that would cooperatively plan and operate disposal sites. Less than a year before the deadline, four regional compacts are awaiting congressional approval; five other regions have draft agreements in various stages of state approval. Even with these compacts, not a single new disposal site is in the firm planning stage. It appears that states accounting for more than half of the volume and nearly three-quarters of the radioactivity of the nation's LLRW may not be ready to assume their responsibilities by next January's deadline. In response to increasing costs and the unavailability of commercial disposal, many nuclear utilities are considering the upgrading of radwaste volume reduction (VR) systems. To aid utilities in assessing VR options, EPRI funded a project to develop a model that could easily and quickly analyze a wide range of technologies and economic factors. The resulting computer code is VRTECH.

Mozes, M. S.

VOLUME REDUCTION OF SPENT ION EXCHANGE RESIN BY ACID DIGESTION
Nuclear Technology, Vol. 59, pp. 270-8, November 1982.

An acid digestion process for reducing the volume and costs for storing waste ion exchange resins contaminated with radioactive substances has been developed on a bench scale. The study was conducted with nonradioactive resin digested in concentrated sulfuric and nitric acids at temperatures of 255 to 290°C. The residue is comprised of metal sulfates that occupy 5% of the original volume. The resin is carbonized by sulfuric acid and oxidized to carbon dioxide and carbon monoxide by both sulfuric and nitric acids. The rates of the four major simultaneous reactions in the digester were determined.

Nakamura, H.; Sato, T.; et al.

REMOVAL OF RADIONUCLIDES OF TRANSITION-METAL ELEMENTS FROM LOW-LEVEL LIQUID WASTE BY THE ELECTROLYTIC FLOTATION METHOD
Radioactive Waste Management and the Nuclear Fuel Cycle, Vol. 3, p. 17, September 1982.

An electrolytic flotation method with aluminum alloy anode has been studied to remove nuclides of transition-metal elements, such as transuranium elements and ^{60}C, from low-level liquid waste. Optimum conditions have been determined by using solutions composed of radioactive tracers and liquid waste from the JAERI Reprocessing Test Plant, which contains a small amount of plutonium.

The presence of sodium salts is preferred in a concentration of less than 0.1 mol/L in order to facilitate this process. The waste is adjusted to be a pH between 4 and 8 before electrolysis. This method is found to be suitable for final treatment to remove transition-metal elements remaining after the usual treatments.

Naretto, C. J.; Semler, T. T.; et al.

A STATISTICAL STUDY OF LOW-LEVEL RADIOACTIVE WASTE GENERATED BY U.S. NUCLEAR POWER PLANTS FROM 1973 TO 1981
EGG-2273, EG&G Idaho, Inc., October 1983.

A comprehensive study is reported on the rates of generation of low-level radioactive waste (LLRW) by U.S. commercial nuclear power reactors. Using the yearly LLRW amounts recorded in the National Low-Level Radioactive Waste Data Base System, historic LLRW generation rates were modeled with linear regression techniques. Time-series linear-regression coefficients were calculated for LLRW generation rates from individual power stations and for groupings of reactors having common characteristics. For boiling water reactors and pressurized water reactors, the amount of LLRW generated per megawatt-electric of rated power increases as a function of time. Model limitations and potential model improvements are discussed.

National Low-Level Radioactive Waste Management Program

AN ANALYSIS OF LOW-LEVEL WASTE DISPOSAL FACILITY AND TRANSPORTATION COSTS
DOE/LLW-6Td, EG&G Idaho, Inc., April 1983.

This publication presents a general overview of the costs involved in low-level radioactive waste disposal, including disposal site costs, consequent prices to be paid by waste generators who use the site, and transportation costs. A number of variables influence site costs: the type of site, size of the site, rate of return on investment, method of financing, etc. Site costs are passed on to waste generators, who also bear the costs of transporting waste material to the site. The costs arrived at, though based on researched data, should be considered only as general estimates. Exact costs are necessarily dependent on specific disposal site conditions; on methods of construction, operation, and financing; and on distances from the sources of waste generation to the disposal facility. This information is primarily intended to assist state officials (executive, legislative, and agency) in planning for low-level waste disposal facilities.

National Low-Level Radioactive Waste Management Program

CORRECTIVE MEASURES TECHNOLOGY FOR SHALLOW-LAND BURIAL
DOE/LLW-13Te, EG&G Idaho, Inc., October 1984.

Based on experience at existing low-level waste burial sites, conditions occur, or may develop, after burial which can cause problems in waste isolation. Even with burial practices that continue to improve, the burial medium remains part of a dynamic environment subject to natural changes that affect waste isolation. These considerations, plus closer scrutiny now given to the operation of burial sites, present the need for assistance in maintaining facilities that are safe. The purpose of this document is to serve as a handbook to operators of low-level waste burial sites for dealing with conditions which can cause problems in waste isolation. This handbook contains information on planning and applying corrective actions, and it is organized in such a way as to assist the operator in associating problems or potential problems with causative conditions. Thus, the operator is encouraged to direct actions at those conditions, rather than the possible temporary expedient of treating symptoms.

National Low-Level Radioactive Waste Management Program

CRITERIA NEEDS FOR SITING, LICENSING, OPERATION, CLOSURE, STABILIZATION, AND DECOMMISSIONING OF SHALLOW-LAND DISPOSAL
DOE/LLW-4T, EG&G Idaho, Inc., November 1982.

This document has been developed by state and local government radiation control personnel to identify those areas in which new or additional criteria are needed for the proper management of low-level radioactive waste. When such criteria have been developed, the decisions that must be made to ensure the proper management of low-level radioactive waste should be uniform; but even more importantly, information will be available on which to make timely decisions. It is strongly recommended that all generators of low-level radioactive waste make every effort to reduce the volume of such generated waste. Another strong recommendation of the committee is for the development of incentives to encourage community acceptance of a shallow-land burial site. Finally, the committee believes that low-level radioactive waste accountability needs to be improved on a state-by-state basis.

National Low-Level Radioactive Waste Management Program

AN ECONOMICS MODEL FOR NEW LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITES
DOE/LLW-25T, EG&G Idaho, Inc., December 1983.

This report describes LLWECON, an interactive computer model for evaluating financial factors involved in low-level radioactive waste disposal. The logic by which LLWECON calculates the final generator price (price per cubic foot the disposal site operator charges waste generators) is detailed. Required user input and hypothetical examples, covering sites with different capacities and both public and private-sector development, are included.

National Low-Level Radioactive Waste Management Program

ENVIRONMENTAL MONITORING FOR LOW-LEVEL WASTE-DISPOSAL SITES
DOE/LLW-13Tg, EG&G Idaho, Inc., January 1983.

A review is made of the purposes, objectives, and principles of environmental monitoring programs and their design. There is a description of environmental monitoring programs based on pathway analysis, critical pathways, waste composition and properties, radiation dosimetry, standards, and the site and area characteristics used to determine sampling locations and frequency. Procedures used to determine where, when, and how often monitoring of specific environmental media should be conducted are described. Statistical aspects of monitoring for the lifetime of a disposal site are explained. There is a discussion of environmental samples collection and general measurement techniques, quality assurance, and data evaluation and reporting. The Appendix gives detailed information on pathway analysis; hydrological measurements; well construction; atmospheric dispersion models; dosimetric quantities, models, and example calculation of off-site annual dose equivalent; and statistical methodologies.

National Low-Level Radioactive Waste Management Program

EXPERIENCE AND RELATED RESEARCH AND DEVELOPMENT IN APPLYING CORRECTIVE MEASURES AT MAJOR LLRW DISPOSAL SITES
DOE/LLW-28T, EG&G Idaho, Inc., August 1984.

This report describes corrective measures for the following seven generic problem conditions at LLRW disposal facilities:

1. unstable trench cover,
2. permeable trench cover,
3. subsidence,
4. groundwater entering trenches,
5. intrusion of deep-rooted plants,
6. intrusion of burrowing animals, and
7. chemical and physical conditions in trenches.

Conclusions drawn in this report are based on the results of experience and research and development projects at six major DOE sites and at the six commercial disposal sites. Three of these commercial sites are no longer operating. Effectiveness of the corrective measures varied due to differences in climatologic, geologic, hydrologic, and biological conditions at these disposal sites. Thus, the report emphasizes the desirability of determining causes of problems to which corrective actions would then be directed.

National Low-Level Radioactive Waste Management Program

INCENTIVES AND COMPENSATION: PROVIDING RESOURCES FOR COMMUNITIES HOSTING LOW-LEVEL WASTE FACILITIES
DOE/LLW-6Te, EG&G Idaho, Inc., October 1982.

State responsibility for the management of low-level radioactive waste necessitates the selection of candidate locations for a disposal facility. Concern over potential impacts can be expected from segments of the citizenry neighboring a proposed site. Several national organizations comprising state and local officials have recommended the use of incentives and compensation to help offset the negative local impacts. This document explores that concept. Discussion provides background information on potential local impacts from a low-level waste facility and considers the nature and types of incentives and compensation benefits that could be provided. The document then examines realistic options for planning and implementing the benefit program. This information is intended, primarily, to assist state officials (executive, legislative, and agency) in planning for and managing low-level waste disposal facilities.

National Low-Level Radioactive Waste Management Program

INSTITUTIONAL RADIOACTIVE WASTES WITH RESTRICTIONS FOR LAND BURIAL AND ENVIRONMENTAL METHODS TO MANAGE SUCH WASTE
DOE/LLW-5T, EG&G Idaho, Inc., November 1982.

Decisive actions must now be taken within a relatively short time to allow for the uninterrupted use of radioactive materials that have been beneficial to mankind. Of particular concern are certain types of radioactive wastes generated by institutions (such as hospitals and universities), which have been restricted from land burial by some of the existing commercial disposal sites. Although usually relatively low in radioactivity, the restricted institutional wastes may be chemically or pathogenically toxic, or the chemicals may degrade disposal site performance.

This document has been developed by state government radiation control personnel with the purpose of identifying the specific types of such institutional wastes that have some type of restrictions on availablity for shallow-land burial, and further, of identifying methods that can be applied to the management of such wastes and that would be environmentally acceptable. Special emphasis was given to incineration as one method of reducing the volume of such wastes.

National Low-Level Radioactive Waste Management Program

LOW-LEVEL RADIOACTIVE WASTE DISPOSAL: COMMERCIAL FACILITIES NO LONGER OPERATING
DOE/LLW-6Tf, EG&G Idaho, Inc., October 1982.

This publication discusses three commercial facilities - no longer operating - that have received and now contain low-level radioactive waste. The facilities are located at West Valley, New York; Maxey Flats, Kentucky; and Sheffield, Illinois. All three of the facilities were selected and developed in the 1960s. The onset of water management problems caused the closure of the sites at West Valley and Maxey Flats in 1975 and 1977, respectively. Closure of the Sheffield site occurred in 1978, after the operator had experienced site problems and consequent lengthy delays in its license renewal procedures. The document provides a detailed explanation of the history, basis for closure, and current status of each facility. This information is intended, primarily, to assist state officials (executive, legislative, and agency) in planning for, establishing, and managing low-level waste disposal facilities.

National Low-Level Radioactive Waste Management Program

LOW-LEVEL RADIACTIVE WASTE DISPOSAL: CURRENTLY OPERATING COMMERCIAL FACILITIES
DOE/LLW-6Tg, EG&G Idaho, Inc., September 1983.

This publication discusses three commercial facilities that receive and dispose of low-level radioactive waste. The facilities are located in Barnwell, South Carolina; Beatty, Nevada; and Richland, Washington. All three facilities initiated operations in the 1960s. They have operated without such major problems as those which led to the closure of three other commercial disposal facilities located in the United States. The Beatty site could be closed in 1983 as a result of a Nevada Board of Health ruling that renewal of the site license would be inimical to public health and safety. The site remains open, pending federal and state court hearings, which began in January 1983, to resolve the Board of Health ruling. The three sites may also be affected by NRC's 10 CFR Part 61 regulations, but the impact of those regulations, issued in December 1982, has not yet been assessed. This document provides detailed information on the history and current status of each facility. The information is intended, primarily, to assist state officials (executive, legislative, and agency) in planning for, establishing, and managing low-level waste disposal facilities.

National Low-Level Radioactive Waste Management Program

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT HANDBOOK SERIES: AN INTRODUCTION
DOE/LLW-13Ta, EG&G Idaho, Inc., August 1983.

This introductory volume for the low-level radioactive waste management handbook series provides general background information concerning low-level waste. Topics covered here are:

1. waste classification;
2. sources and forms of low-level waste;
3. various waste treatment methods presently employed by low-level waste generators;
4. low-level waste generation rates;
5. practices and regulations for packaging, transportation, and personnel and environmental monitoring;
6. history of commercial shallow-land disposal sites;
7. typical operating practices at shallow land disposal sites.

Also, a glossary of terms that appear throughout the handbook series and a selected bibliography of publications related to low-level waste management are included as appendixes.

National Low-Level Radioactive Waste Management Program

LOW-LEVEL RADIOACTIVE WASTE TREATMENT TECHNOLOGY
DOE/LLW-13Tc, EG&G Idaho, Inc., July 1984.

Each generator of low-level radioactive waste must consider three sequential questions: (1) Can the waste in its as-generated form be packaged and shipped to a disposal facility? (2) Will the packaged waste be acceptable for disposal? and (3) If so, is it cost-effective to dispose of the waste in its as-generated form? These questions are aimed at determining if the waste form, physical and chemical characteristics, and radionuclide content collectively are suitable for shipment and disposal in a cost-effective manner. If not, the waste management procedures will involve processing operations in addition to collection, segregation, packaging, shipment, and disposal.

This handbook addresses methods of treating and conditioning low-level radioactive waste for shipment and disposal. A framework is provided for the selection of cost-effective waste-processing options for generic categories of low-level radioactive waste. The handbook is intended as a decision-making guide that identifies types of information required to evaluate options, methods of evaluation, and limitations associated with selection of any of the processing options.

National Low-Level Radioactive Waste Management Program

MANAGING LOW-LEVEL RADIOACTIVE WASTES: A PROPOSED APPROACH
DOE/LLW-9, EG&G Idaho, Inc., April 1983.

This document outlines and discusses philosophy, policy, and a general strategy for the future management of low-level radioactive wastes. Representing a national policy for all aspects of low-level waste management, it will help guide relevant agencies in designing program plans and setting priorities for technology development. It establishes a working relationship between the federal and state governments for resolving problems with managing the system of low-level waste disposal. Finally, as a guide designed to provide the reader with an understanding of low-level wastes, it is an instrument for public involvement. Chapter 2 provides basic information on low-level wastes, their generation, and their management. It also discusses DOE technology development programs and various federal regulatory responsibilities as a reference for the policy discussions that follow. The body of this document addresses issues related to the major components of the low-level waste management system. In each chapter, several policy options are proposed. The existing situation is presented as the first alternative. One alternative is recommended for adoption, and the basis for its selection is explained.

National Low-Level Radioactive Waste Management Program

MASSACHUSETTS LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT SURVEY
DOE/LLW-19T, EG&G Idaho, Inc., March 1983.

During 1982, Inter/Face Associates, Inc., undertook the following tasks for the U.S. Department of Energy's National Low-Level Waste Management Program:

Task 1: In conjunction with EG&G Idaho, Inc., the DOE's lead contractor for LLRW management, identified data needs for LLRW management, and uses of the data.

Task 2: Developed and pretested a management questionnaire to elicit the necessary data.

Task 3: Assisted the Radiation Control Program of the Massachusetts Department of Public Health in fielding the management questionnaire.

Task 4: Verified survey responses and entered the data on a computer system supplied by EG&G Idaho, Inc.

Task 5: Assisted EG&G Idaho, Inc., in analyzing the data.

National Low-Level Radioactive Waste Management Program

METHODS TO DECREASE LOW-LEVEL WASTE GENERATION
DOE/LLW-13Tb, EG&G Idaho, Inc., December 1982.

A study of the methods of low-level waste generation by commercial nuclear fuel-cycle facilities; installations engaged in government-related nuclear activities; hospitals, universities, and research foundations that use nuclear materials for research; and industrial processors and users of radioactive materials was made by site visits and interviews. The literature on low-level waste was also reviewed to obtain documentation on preventive waste generation. Few unique developments or technological breakthroughs have been identified. The most significant waste-generation reduction results from systematic evaluation of waste generation factors throughout the facility. Methods of decreasing waste generation in terms of facility and equipment design, operation and maintenance, decontamination, and administrative controls are presented with cost/benefit relationships and examples of each method. Appendix A documents the need for decreased low-level waste generation. A bibliography is provided for each method discussed in the handbook.

National Low-Level Radioactive Waste Management Program

THE 1980 STATE-BY-STATE ASSESSMENT OF LOW-LEVEL RADIOACTIVE WASTES SHIPPED TO COMMERCIAL DISPOSAL SITES
LLWMP-IIT, EG&G Idaho, Inc., June 1982.

This report, issued for the first time in 1979, attempted to segment the waste into four broad categories (institutional, industrial, commercial, and government) and to allocate volumes to each of these categories by state of origin. Where published data existed, they were used as the basis for part of the allocations. Information from reports containing national averages of waste volumes was combined with regional data to arrive at regional (state) estimates. The remaining volume, classified as industrial in type, was spread over the nation generally in proportion to the population of each state and the number of radioactive material licensees. Appendix Table A-1 shows the approximate volume of wastes shipped to commercial disposal sites by state, along with each state's percentage of the U.S. total. In addition, the activity by state, along with each state's percentage of the U.S. total radioactivity, is shown. Appendix Table A-2 compares volume and volume percentages given in Table 1 to the 1979 reported volume and volume percentages.

National Low-Level Radioactive Waste Management Program

PLANNING STATE POLICY ON LOW-LEVEL RADIOACTIVE WASTE
DOE/LLW-6T, EG&G Idaho, Inc., October 1982.

Most of the states face a growing problem in the management of low-level radioactive waste generated within their borders. The current uncertainty regarding the availability of disposal sites for these waste products exacerbates their increasing generation rate. The purpose of this publication is to assist state governments in planning effective policy to address these problems. Background information is presented on the current situation, the responsibilities of state government, and the assistance available to states from federal agencies and national groups. The document then focuses on state policy planning, including: (1) methodology for assessing a state's current waste management status and for projecting future needs, (2) consideration of waste management options for a state, and (3) insight into the possible effects and implications of planned policies. This information is intended primarily for state officials (executive, legislative, and agency) and does not include detailed technical information on waste characteristics or handling techniques.

National Low-Level Radioactive Waste Management Program

PROCEDURAL AND TECHNICAL REQUIREMENTS FOR SITING LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITIES
DOE/LLW-30T, EG&G Idaho, Inc., July 1984.

With the passage of the Low-Level Waste Policy Act of 1980, the responsibility for providing facilities for the safe and efficient disposal of low-level waste has been placed on the states. Most states have chosen to share the responsibility with neighboring states through the formation of regional interstate compacts. The compacts will differ in their functional authority; some will merely assist the member states, while others will act as a regional government in the area of LLRW management. In all regional arrangements, an individual state will be required to host the regional disposal facility. As a result, a multiplicity of entities will be involved, each of which will have its own operating approach and practices. It is important, therefore, that guidelines be developed that enable each participant to adopt procedures tailored to meet particular needs but which form a common basis of practice. The purpose of differences in the procedures employed by the various entities can be readily understood and not allowed to cause confusion and delay. With the publication by the NRC of final rules on Licensing Requirements for Land Disposal of Radioactive Waste, it is now possible to factor these requirements into guidelines.

National Low-Level Radioactive Waste Management Program

PROCEDURES AND TECHNOLOGY FOR SHALLOW-LAND BURIAL
DOE/LLW-13Td, Oak Ridge National Laboratory, August 1983.

This handbook provides technical information on the requirements, activities, and roles of all parties involved in the development and operation of new, shallow-land burial facilities for the disposal of low-level radioactive waste (LLRW). It presents an overview of site selection, design, construction, operation, and closure. LLRW shallow-land burial practices and new technology applications are described. The handbook is intended to provide a basis for understanding the magnitude and complexity of developing new low-level waste disposal facilities.

National Low-Level Radioactive Waste Management Program

A PROCESS FOR LOCATING SHALLOW-LAND BURIAL SITES FOR LOW-LEVEL RADIOACTIVE WASTE
DOE/LLW-16T, EG&G Idaho, Inc., March 1983.

The report discusses the development of a screening process for siting low-level radioactive waste disposal facilities and describes a test application of that process in Tennessee. The site-selection criteria were developed based on the Nuclear Regulatory Commission's disposal regulation, 10 CFR 61. Data on the geologic, hydrologic, and geographic sytems in Tennessee were analyzed to select a suitable area for low-level waste disposal. Selection of the best candidate area was based on: remoteness from population centers, availability of major transportation systems, low risk of flooding, erosion resistance, lack of geologic hazards, and other factors.

National Low-Level Radioactive Waste Management Program

RADIOACTIVE WASTE INCINERATION AT PURDUE UNIVERSITY
DOE/LLW-12T, EG&G Idaho, Inc., November 1982.

This report describes a study conducted at Purdue University to evaluate the feasibility of using a small (45-kg/h), inexpensive (less than $10,000) incinerator for incinerating low-level radioactive waste. An oil-fired, dual-chamber, pathological waste incinerator was installed on a 12.7-cm-thick concrete floor in a metal quonset building. A standard EPA Method 5 sampling train was used to obtain stack samples. Also, stack gas velocity was measured with a type 5 pitot tube; stack temperature was measured with a thermocouple and a pyrometer.

Results of the study demonstrated the feasibility and cost-effectiveness of incinerating radioactive animal carcasses and liquid scintillation fluids, since emissions from those waste types were within EPA and State of Indiana limits. However, emissions from the burning of trash exceeded State of Indiana limits. Therefore, incineration of trash alone, particularly if it contains glass or significant amounts of plastic, is not a recommended use of the tested equipment.

National Low-Level Radioactive Waste Management Program

THE SITING PROCESS: ESTABLISHING A LOW-LEVEL WASTE DISPOSAL FACILITY
DOE/LLW-6Tc, EG&G Idaho, Inc., November 1982.

The siting of a low-level radioactive waste disposal facility encompasses many interrelated activities and, therefore, is inherently complex. The purpose of this publication is to assist state policymakers in understanding the nature of the siting process. Initial discussion focuses on the primary activities that require coordination during a siting effort. Available options for determining site development, licensing, regulating, and operating responsibilities are then considered. Additionally, the document calls attention to technical services available from federal agencies to assist states in the siting process; responsibilities of such agencies are also explained. The appendixes include a conceptual plan for schedulng siting activities and an explanation of the process for acquiring "agreement state" status. An agreement state takes responsiblity for licensing and regulating a low-level waste facility within its borders.

National Low-Level Radioactive Waste Management Program

SURVEY OF CHEMICAL RADIOLOGICAL INDEXES EVALUATING TOXICITY
DOE/LLW-17T, EG&G Idaho, Inc., March 1983.

This document reviews and evaluates 18 chemical and radiation standards, criteria, and measures that might form the basis of a combined radiochemical toxicity index for low-level radioactive waste. Six measures are recommended for the index basis and are evaluated in greater detail.

National Low-Level Radioactive Waste Management Program

TRANSPORTING LOW-LEVEL WASTE: EFFECTS OF REGIONAL MANAGEMENT
DOE/LLW-6Tb, EG&G Idaho, Inc., November 1982

This publication discusses the beneficial effects that regional management can have on transporting low-level radioactive wastes. Locations of the three currently operating disposal sites — one each in South Carolina, Washington, and Nevada — are widely dispersed and far from the sources of much of the nation's low-level waste. Establishment of regionally located sites would effectively reduce the distance, cost, and hazards of transport. Cited analytical work provides quantitative support of this appraisal. This information is intended, primarily, to assist state officials (executive, legislative, and agency) in the management of commercial low-level radioactive waste.

National Low-Level Radioactive Waste Management Program

UNDERSTANDING LOW-LEVEL RADIOACTIVE WASTE
DOE/LLW-2, EG&G Idaho, Inc., October 1983

This is a general tutorial document that covers all aspects of commercial and DOE LLRW, including the applicable government laws.

National Low-Level Radioactive Waste Management Program

WASTE CLASSIFICATION, A PROPOSED METHODOLOGY FOR CLASSIFYING LOW-LEVEL RADIOACTIVE WASTE
DOE/LLW-14T, EG&G Idaho, Inc., December 1982.

Since low-level radioactive waste presents both a chemical and a radiological hazard, it is desirable that management practices take this into account. This paper describes a waste classification system that could provide a basis for such management practices.

The classification method formulates the hazard of waste as the ratio of potential exposure or intake to a selected limit. Potential exposure or intake incorporates four factors: (1) the nature and (2) amount of toxic materials disposed of in the soil, (3) the availability of the waste to enter an environmental pathway potentially exposing humans, and (4) the decay products. The system could provide guidance on how mixed wastes should be separated for disposal and on the degree of disposal isolation each waste material or shipment needs. Examples of the system's use are provided.

Naughton, M. D.

EPRI RADWASTE SEMINAR
Seminar, BVC Consultants, EPRI, Chicago, Illinois, September 19-21, 1984.

The second in a series of annual EPRI radwaste seminars was held in Chicago, Illinois, on September 19-21, 1984. The seminar was directed to utility personnel involved in the engineering and operation of nuclear plant radwaste systems. The scope of the meeting included presentations and attendee discussions in three major areas:

1. advanced VR performance and economics,
2. radwaste processing studies, and
3. radwaste testing and assay methods.

These proceedings do not repeat the formal presentations since copies of these were distributed at the seminar. They include the edited comments, questions, and answers following each of the presentations.

Naughton, M. D.

PROCEEDINGS: 1984 ASME-EPRI RADWASTE WORKSHOP
EPRI NP-3680, BVC Consultants, EPRI, September 1984.

The proceedings of the sixth ASME-EPRI jointly sponsored radwaste workshop are presented. The theme of this year's workshop was "Technological Changes and the Radwaste Organization." Presentations and discussion sessions were organized for the following topics:

1. compliance with 10 CFR 61 sampling requirements,
2. radwaste training and organization, and
3. radwaste equipment and process update.

Presentations were also made on the status of ongoing regulatory actions on LLRW state compacts, DOT regulations, and de minimus quantity.

Naughton, M. D.

WORKSHOP PROCEEDINGS: 1982 ASME-EPRI RADWASTE WORKSHOP
EPRI NP-2450, BVC Consultants, Inc., EPRI, June 1982.

The proceedings of the fourth ASME-EPRI jointly sponsored workshop are presented. This year's meeting had the theme of radwaste minimization, process options, and regulatory impact.

A description of two new EPRI sponsored projects and summaries of the workshop proceedings on process options and radwaste minimization are included in the proceedings.

Neal, T. P.; Miller, C. C.; Naughton, M. D.

OPERATIONAL EXPERIENCE OF THE PALISADES VOLUME REDUCTION SYSTEM - THE FIRST 12 MONTHS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 545-9, March 1985.

The operating experience of the first extruder-evaporator volume reduction and solidification system in the United States is discussed. The performance of the system during its first year of operation is presented. The labor and maintenance requirements for the system during the first year are also discussed.

Negin, C. A.; Urland, C. S.; Hitz, C. G.

ESTIMATING WASTE DISPOSAL QUANTITIES FROM RAW WASTE SAMPLES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 597-601, March 1985.

Estimating the disposal quantity of waste resulting from the stabilization of radioactive sludge is complex because of the many factors relating to sample analysis results, radioactive decay, allowable disposal concentrations, and options for disposal containers. To facilitate this estimation, a microcomputer spreadsheet template was created. The spreadsheet has saved considerable engineering hours.

Neilson, R. M., Jr.

SOLIDIFICATION OF LOW-LEVEL WASTES FROM COMMERCIAL POWER REACTORS
Nuclear Safety, Vol. 24, No. 2, March-April 1983.

The successful application of various agents for the solidification of wet solid wastes from commercial power reactors requires insight concerning their use and limitations. Solidification agents and their applicability to specific waste types are discussed in the context of waste management operations and existing regulatory requirements. Formulators of future requirements and burial site acceptance criteria will likely consider waste form properties and performance in the disposal environment. Test methods for the measurement of relevant waste form properties are discussed, and a qualitative waste form comparison is given.

Neilson, R. M., Jr.; Colombo, P.

SOLIDIFICATION OF ION EXCHANGE RESIN WASTES
BNL-51615, Brookhaven National Laboratory, August 1982.

This topical report describes the results of an investigation of the solidification of ion exchange resin wastes. The solidification media investigated included Portland type I, Portland type III, and high-alumina cements; a proprietary gypsum-based polymer-modified cement; and a vinyl ester-styrene thermosetting plastic. Work was conducted to determine compositional envelopes which will produce acceptable waste forms. Imposed acceptability criteria required that waste forms be monolithic freestanding solids with no freestanding water and be able to withstand a 2-week immersion test without loss of mechanical integrity. Samples formulated with hydraulic cement were analyzed to investigate the effects of resin type, resin loading, waste/cement ratio, and water/cement ratio.

Neuhauser, K. S.; Cashwell, J. W.; Reardon, P. C.; McNair, G. W.

A PRELIMINARY COST-AND-RISK ANALYSIS FOR TRANSPORTING SPENT FUEL AND HIGH-LEVEL WASTES TO CANDIDATE REPOSITORY SITES
SAND84-1795, Sandia National Laboratories, 1984.

This report discusses the relative costs and risks of transporting nuclear wastes to nine potential candidate repository sites. The calculations performed are consistent with a previous TTC study (Wilmot et al., 1983), but the analyses have been updated to reflect programmatic assumptions about cask capacities and repository capacity in order to be consistent with environmental assessments written under the Nuclear Waste Policy Act. Because of the complexity of the issues, as well as their regional character, costs and risks should be considered to be relative indicators among the various sites.

Newby, B. J.; Nichols, J. T.; Hoskins, A. P.

CALCINATION OF WM-183 WASTE
ENICO-1128, Exxon Nuclear Idaho Company, Inc., June 1983.

One of the principal tasks at the Idaho Chemical Processing Plant is the calcining of liquid waste generated from processing spent nuclear fuels. This report discusses flowsheet development work done to process the waste in tank WM-183 — a blend of aluminum nitrate, electrolytic first-cycle extraction, and sodium wastes. Yet, since the development of the original flowsheet, the waste in tank WM-183 has been concentrated, blended with other wastes, and transferred to tank WM-189. However, the work described in this report was used to choose a method for calcining this modified waste. It is being calcined as a blend with zirconium fluoride waste, with enough calcium nitrate being added to the blend to give it a calcium/fluoride mol ratio of 0.60 to 0.70. The work done in this report will also hopefully expedite the processing of other waste blends.

Nishihara, Y.; et al.

STABILIZING SOLIDIFICATION II: FUNDAMENTAL TEST OF THE WASTE SOLIDIFICATION PROCESS UTILIZING HYDROTHERMAL REACTION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 177-80, March 1985.

A fundamental test of the hydrothermal solidification process was performed for the purpose of developing the solidification system capable of transforming the powder wastes generated from the calciner (or dryer) and incinerator in the nuclear plant to a long-term stable and rigid form. The results are presented in this paper. From these results, we obtained a fair prospect for the practical use of this process.

Nojima, Y.; Iimura, I.; Takeda, K.; Kawaguchi, A.

OPERATIONAL EXPERIENCE IN THE LOW-LEVEL LIQUID WASTE TREATMENT AT TOKAI REPROCESSING PLANT
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 505-15, August 26-29, 1984.

At Tokai, reprocessing commenced in September 1977. About 174 Mg of initial uranium in spent fuels transported from the Japanese nuclear power stations have been reprocessed through December 1983. The relatively large quantities of low-level liquid wastes generated during this period have been treated safely using a low-level waste treatment process, which has been in successful operation so far. This paper describes the operational experience of the low-level liquid waste treatment at the Tokai plant.

Noland, J. W.; Sisk, W. E.

INCINERATION OF EXPLOSIVES-CONTAMINATED SOILS
Presented at the 13th Annual Environmental Systems Symposium, Roy F. Weston, Inc., March 1984.

The objectives of the Incineration of Explosives-Contaminated Soils (IECS) project were as follows:

1. the primary objective of these tests was to demonstrate the effectiveness of incineration as a decontamination method for explosives-contaminated soils.
2. the secondary objectives of the project were to:
   (a) develop a data base and appropriate correlations for designing and predicting the performance of the incinerator as a decontamination method,
   (b) determine the fate of the explosives and metals in the contaminated soils during/after incineration, and
   (c) measure pollutant levels in the stack gas to determine the air pollution control devices that would be required for incinerators that may be used in the future to incinerate explosives-contaminated soils.

Nott, B. R.

ELECTRODIALYTIC DECONTAMINATION OF SPENT ION EXCHANGE RESINS FROM CANDU PRIMARY HEAT TRANSPORT PURIFICATION CIRCUITS
IAEA-SM-264/32, Onatario Hydro, November 1982.

The development of a novel electrodialytic decontamination process for the selective removal of radioactive Cs from spent Li-form ion exchange resins from CANDU Primary Heat Transport (PHT) purification circuits is described. The process involves passage of a dc electric current through a bed of the spent ion exchange resin in a specially designed electrodialytic cell. The radiocesium so removed from a volume of the spent resin is concentrated onto a much smaller volume of a Cs selective sorbent to achieve a significant radioactive waste volume reduction. Technical feasibility of the ElectroDialytic Resin Decontamination (EDRD) process has been demonstrated on a bench scale with a batch of simulated spent ion exchange resin and using potassium cobalt ferrocyanide as the Cs selective sorbent. A volume reduction factor greater than 10 was achieved. The process appears to be economically attractive. The EDRD process can also be effectively applied to in-line purification in the PHT circuits of CANDU reactors to minimize the volume of ion exchange resin usage.

Notz, K. J.

RADWASTE INVENTORIES AND PROJECTIONS: AN OVERVIEW
ORNL/TM-8322, Oak Ridge National Laboratory, July 1982.

The Integrated Data Base (IDB) program is sponsored by the Department of Energy (DOE) to provide fully integrated and reconciled inventories, characteristics, and projections (including alternative cases) for spent nuclear fuel and all categories of radioactive waste. The summary papers included in this compendium are drawn from a special session on "Radwaste Inventories and Projections" given at the American Nuclear Society Meeting in Los Angeles, June 1982. In addition, two other papers are included that were not given at that meeting in order to properly round out this overview.

The IDB program works with, draws on, and provides supporting information to DOE and its contractors in the areas of systems analysis, spent fuel, high-level waste, TRU waste, low-level waste, airborne waste, fuel recycle and transportation, waste isolation, and remedial action programs. These papers cover: a broad overview of data needs and functions, the IDB inventory and projection functions; systems analysis application; data needs for national waste terminal storage; and applications to and from LLRW, HLRW, and TRU waste.

Nuclear Energy Low-Level Radioactive Waste Management Program

LONG-RANGE PLAN FOR NUCLEAR ENERGY LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT PROGRAM
United States Department of Energy, November 1984.

The Nuclear Energy Low-Level Waste Management Program facilitates the establishment of a reliable system for treatment and disposal of commercially generated low-level waste, evaluates this system in terms of operational efficiency by 1988, and develops plans and procedures for implementation of DOE responsibilities. The Nuclear Energy Low-Level Waste Management Program is a key element in the successful implementation of a regional system of commercial low-level waste management facilities. The Program makes available for private sector use applicable treatment and disposal technology developed through extensive DOE experience and research, fosters selected cooperative technology development demonstrations with States and industry, and provides technical assistance for efforts resulting in the establishment of new low-level waste disposal facilities. The Program provides a means for states to rely on a broad range of expertise and operational experience in low-level waste treatment and disposal while they establish the necessary institutional framework and techniques for development and operation of new low-level waste disposal facilities resulting in an improved low-level waste management system.

Nuclear Engineering International

AZTECH SOLIDIFICATION SYSTEM OFFERS ADVANTAGES
Nuclear Engineering International, Vol. 28, No. 338, pp. 46-47, March 1983.

General Electric's Nuclear Energy Operations has reported the development of a nuclear plant low-level radwaste processing system which reduces solidified waste volume to 10 to 50 % of that produced by a typical cement system in general use today. The process will treat BWR and PWR wastes. Aztech applies vacuum azeotropic distillation technology to remove water from low-level nuclear plant wastes and encapsulates them into a dense, plastic product which has very low leachability. Azeotropic distillation occurs when a mixture of two components boils at a temperature different from the boiling point of either. The boiloff vapors contain a fixed ratio of the two. In the Aztech process, a minimum boiling-point azeotrope is formed between water and a polyester monomer.

Nuclear Power Newsletter

ADDRESSING WASTE ISSUES WITH TECHNOLOGY, EXPERIENCE, IMAGINATION
Promotional Brochure, General Electric Company, 1985.

General Electric's (GE's) activities in waste management cover a full spectrum and can be viewed as spanning three main areas: (1) low-level radioactive waste, (2) high-level radioactive waste, and (3) decommissioning. Under low-level radwaste, GE offers treatment and packaging of liquid waste, dry waste, and irradiated hardware at reactor sites. The interim storage of spent fuel at reactor sites, casks for transport of spent fuel to permanent repositories, and design and development of equipment and systems for permanent repositories constitute the current offerings in the high-level area. Dismantlement of reactors, both public and private, that have completed their useful life, plus decontamination and decommissioning of radioactive facilities such as transuranic processing plants, make up the latest addition to GE waste management services.

Nuclear Regulatory Commission

A HANDBOOK OF ACRONYMS AND INITIALISMS
NUREG-0544, Rev. 1, Nuclear Regulatory Commission, April 1981.

This handbook provides an alphabetically arranged list of acronyms, initialisms, and similar condensed forms observed in use in the nuclear industry. The distinction between acronyms and initialisms is as follows:

Acronym - a pronounceable term formed from the initial letters of a compound expression: FEMA is formed from Federal Emergency Management Agency and rem from roentgen equivalent man.

Initialism - a nonpronounceable term formed from the initial letters of a compound expresion: GAO from General Accounting Office and ac for alternating current.

When using these, or similar, condensed forms in your writing, write out the full expression the first time it appears, followed by the acronym or initialism in parentheses. Thereafter, the condensed form can be used.

NUKEM

VOLUME REDUCTION AND SOLIDIFICATION SYSTEMS FOR RADWASTE
Hanau-11, NUKEM, July 1984.

Various processes can be applied to prepare radioactive wastes for final storage and optimize costs at the same time. These processes depend on the properties of the waste and the required specifications. Optimizing the costs (i.e., mainly reducing the volume) is associated with transportation costs to the burial site.

Volume reduction and solidification systems can be applied for the following low-, medium- and high-level waste streams:

1. noncombustible waste,
2. combustible solid and liquid waste,
3. ion exchange resins/spent solvent (TBP), and
4. compactible waste.

NUS Corporation

DOE ORDER 5480.2 HAZARDOUS WASTE MANAGEMENT PLANS: LISTING OF TREATMENT, ETC., OF NONCOMPLIANCE ITEMS BY WASTE TYPE FOR MMES
NUS Project No. 981, Rockville, Maryland, January 1985.

This report presents the results of an NUS review of the hazardous waste treatment, storage, and disposal (TSD) units identified in Hazardous Waste Management Plans (HWMPs) submitted to U.S. Department of Energy Headquarters (DOEHQ) under DOE Order 5480.2, HAZARDOUS AND RADIOACTIVE MIXED WASTE MANAGEMENT.

A table is provided which shows that 44 % (125) of the TSD units were reported to manage only RCRA hazardous wastes, and only 14% (17) of these units were reported to be in compliance.

NUS Corporation

SEMINAR SUMMARY OF NUS COMPLETED: ETC.
NUS Project No. 6981, Rockville, Maryland, February 1985.

Entire title:

SEMINAR SUMMARY OF NUS COMPLETED: TECHNICAL SUPPORT TO ORNL FOR EVALUATION OF DOE ORDER 5480.2 HAZARDOUS WASTE MANAGEMENT PLANS (HWMPS) AND IMPLEMENTATION PLANS (IPs) FOR MARTIN MARIETTA ENERGY SYSTEMS, INC., OAK RIDGE, TN

Tasks include:

1. Task 1 - IP Review,
2. Task 2 - Assist in DOE-HQ IP "Approval" Process, and
3. Task 3 - HWMP Review.

NUS Corporation

A WORKSHOP FOR HAZARDOUS AND RADIOACTIVE MIXED WASTE MANAGEMENT
Rockville, Maryland, January 1984.

This workshop was to aid generators, handlers, etc., of hazardous waste in the management of that waste.

Included in the workshop were the following:

1. Case Study of Industrial Facility
   (a) Waste Analysis Plan
   (b) Contingency Plan
   (c) Closure and Postclosure Plan
2. Schedule for Inspection and Inspection Log
3. Personnel Training Program
4. Operating Record
5. RCRA Directions
6. Identification of a Hazardous Waste
7. Laboratory Aspects of RCRA
8. Appendices - Including the Federal Register List of Hazardous Wastes

NUS Processing Services Corporation

MOBILE LIQUID ABRASIVE DECONTAMINATION
Promotional Brochure, NUS Process Services, 1975.

To develop the NUS Liquid Abrasive Decontamination system, NUS has adapted techniques used in Europe over the last decade. The entire decontamination system is self-contained in a 40-ft (12-m) trailer. All decontamination is performed inside an enclosed booth within the trailer. The booth measures 6 x 4 x 4 ft (1.8 x 1.2 x 1.2 m) and can hold up to 1000 lb (454 kg) of material. At the bottom of the booth is a sump that contains a slurry of preselected abrasion particles suspended in water. About 50 gal (190 L) of slurry continuously recirculate at high flow rates through a nozzle. A technician handles the nozzle through glove ports in the enclosed booth.

No corrosive or volatile chemicals, which could damage reusable items, are used. Eight control variables affect the surface removal of the part being decontaminated, including water pressure, air pressure, and abrasive material selected. The correct combination enables the technician to scrub an item with only negligible surface material removal, or if required, to remove 0.25 in. (6-mm) of metal from a steel surface in less than 10 min.

NUS Processing Services Corporation

MOBILE RADWASTE SOLIDIFICATION
Promotional Brochure, NUS Processing Services, 1985.

NUS offers a complete Mobile Radwaste Solidification Service, including equipment, liners, chemicals, technicians, and Process Control Program (PCP) needed to process any waste. Process shields and cask transportation are also available. System installation, including review and approval of the PCP, usually takes less than 2 d. NUS provides a PCP for each type of waste to be processed. The PCP, a generic document on file with the NRC, specifies solidification procedures and requirements. It incorporates sampling requirements, process variables, scaling calculations, and data sheets for monitoring and controlling the solidification process. The PCP also provides the acceptance criteria for both sample and full-scale solidification to ensure compliance with all requirements, including 10 CRF 61. At the utility's option, a generic PCP can be customized for inclusion in the plant's operating procedures. When radwaste is ready for solidification, its specific formulation is verified through the PCP and transferred to a disposable liner. After it is chemically pretreated, Portland cement is blended into it, and the resulting cement slurry cures for 24 to 48 h. NUS then conducts quality checks and prepares the liner for shipment.

NUS Processing Services Corporation

RADIOACTIVE WASTE TRANSPORTATION
Promotional Brochure, NUS Process Services Corporation, 1975.

NUS Process Services offers four radwaste transportation plans:

1. Demand Service,
2. Operating Lease,
3. Capital Lease, and
4. Equipment Purchase.

NUS Processing Services Corporation

TRANSFIX: THE MOST EFFICIENT TRANSPORTABLE RADWASTE PROCESSING SYSTEM AVAILABLE
Promotional Brochure, NUS Processing Services, 1985.

TRANSFIX Service decontaminates radwaste water by passing it through vessels containing filtration media and ion exchange resins. Disposable vessels made of carbon steel or nondisposable, stainless-steel vessels with resin sluicing capability are provided. When the capability to remove radioactive material is exhausted, disposable vessels are dewatered or solidified in situ and then shipped to a low-level radwaste disposal site. In both cases, the resulting end product contains zero freestanding water and complies with all federal and state disposal regulations. All vessels are fabricated in compliance with Section VIII of the ASME Boiler and pressure Vessel Code.

TRANSFIX equipment includes process control skids, shielding, disposable and nondisposable vessels, dewatering skids, and solidification or resin sluicing equipment.

Oakes, T. W.; Parzyck, D. C.

ENVIRONMENTAL MANAGEMENT AT ORNL - FIVE-YEAR PROJECT PLAN FY 1985-1989
ORNL/TM-9200, Oak Ridge National Laboratory, June 1984.

The Environmental Management Project Plan for ORNL includes an introduction, a description of environmental operations at ORNL, a discussion of waste management operations at ORNL, and the five-year project plan. Recently, significant programs at the Laboratory have been changed from an emphasis that was almost wholly nuclear to programs that include large commitments to nonnuclear technologies. Some of these technologies involve nonradioactive, but nonetheless hazardous, materials. In addition, new legislation and intensified awareness of environmental issues are increasing the requirements for monitoring, controlling, and reporting of nonradioactive pollutants. This necessitates an Environment Management program that is not only responsive to the needs of these nonnuclear programs but also prepared to meet the challenge of all upcoming laws and environmental issues. In the Five-Year Plan, an attempt is made to provide a comprehensive picture of ORNL's environmental projects, including line-item and GP projects proposed by the Laboratory and the Waste Management Program. Priorities have been established for these projects, based on the severity of the problem(s) they address.

Oak Ridge National Laboratory

Abstracts from the SIXTH ANNUAL DOE LLWMP PARTICIPANTS' INFORMATION MEETING
CONF-8409115-Abstracts, Oak Ridge National Laboratory, September 11-13, 1984.

Plenary Session I - 7 papers
Plenary Session II. - 3 papers
SESSION I: A. Disposal Technology - Improved Shallow Land Burial - 11 papers
B. Disposal Technology - Greater Confinement Disposal - 4 papers
C. Disposal Technology - Corrective Measures - 6 papers
SESSION II: Characteristics and Treatment of Low-Level Waste - 14 papers
SESSION III: Environmental Aspects and Performance Prediction - 10 papers
Workshop A. Predicting Source Terms for Low-Level Waste - 1 paper
Workshop B. Performance Assessment for Low-Level Disposal Facilities - 1 paper
Workshop C. Approaches to Low-Level Disposal Facility Siting and Characterization - 2 papers
Overall Summary Sessions

Oak Ridge National Laboratory

MANAGEMENT OF INTERMEDIATE-LEVEL RADIOACTIVE WASTE
ERDA-1558, Oak Ridge National Laboratory, September 1977.

This environmental impact statement was prepared in accordance with the National Environmental Policy Act of 1969. Reasonable alternative techniques are analyzed. The facility requirements necessary to implement the technique are analyzed, and the potential environment impacts of the available alternatives are assessed.

Normal operations at Oak Ridge National Laboratory (ORNL) generate up to 2,000,000 gal/year (7,500 m^3/year) intermediate-level waste solution having an average activity concentration of ~0.01 Ci/gal (~5 to 15 Ci/m^3). The liquid is concentrated by evaporation, and from 1966 to 1985 was periodically disposed of by shale fracturing.

A study was made at ORNL of various alternatives to shale fracturing. All of these alternatives would result in the conversion of ORNL waste solution and sludge into a solid, nonburnable waste form suitable for temporary on-site storage and for ultimate shipment off-site for disposal at a Federal repository. Eleven processes for the immobilization of LLRW solution were considered.

Oak Ridge National Laboratory

SPENT FUEL AND RADIOACTIVE WASTE INVENTORIES, PROJECTIONS AND CHARACTERISTICS
DOE/NE-0017/3, Oak Ridge National Laboratory, 1984.

Current inventories and characteristics of commercial spent fuels and both commercial and U.S. DOE radioactive wastes were compiled through December 31, 1983, based on the most reliable information available from government sources and the open literature, technical reports, and direct contacts. Future waste and spent fuel to be generated over the next 37 years and characteristics of these materials are also presented, consistent with the latest DOE/Energy Information Administration (EIA) projection of U.S. commercial nuclear power growth and expected defense-related and private industrial and institutional activities.

Materials considered, on a chapter-by-chapter basis, are: spent fuel, high-level waste, transuranic waste, low-level waste, commercial uranium mill tailings, airborne waste, remedial action waste, and decommissioning waste. For each category, current and projected inventories are given through the year 2020; and the radioactivity and thermal power are calculated, based on reported or calculated isotopic compositions.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - GE PINELLAS
Oak Ridge National Laboratory, September 10, 1984.

The Pinellas Plant, located in Pinellas, Florida, generates mainly industrial wastes (including sanitary) disposed of through the Pinellas County Sewer System or hazardous wastes disposed of through off-site commercial disposal or reclamation facilities. Solid radioactive wastes are sent to the Savannah River Plant. A very small quantity of explosive waste material is generated and is disposed of on-site by thermal treatment (burning).

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - KANSAS CITY BENDIX PLANT
Oak Ridge National Laboratory, January 21, 1985.

The Kansas City Plant (KCP), managed by the Bendix Corporation for DOE, produces nonnuclear components for the DOE weapons program.

The KCP generates about 25 hazardous waste streams in the form of solvents, spent plating wastes, machine coolant wastes, PCBs, photographic waste, paints and thinners, fuels and oil, mercury, asbestos, aerosol products, adhesives, and potting operation wastes.

The two waste treatment facilities on-site are: (1) A solvent recovery distillation unit, and (2) An oil/water separator for dewatering oils.

All waste is disposed of off-site by selected commercial disposers. At present, there are four waste storage areas and four aboveground bulk storage tanks at this facility.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - LOS ALAMOS NATIONAL LABORATORY
Oak Ridge National Laboratory, August 20, 1984.

Los Alamos National Laboratory (LANL) is a multiprogram, research and development facility located about 48 miles (77 km) northwest of Santa Fe. Slightly over one-half of its annual funding comes from the DOE weapons program. The remainder comes from other DOE programs and other agencies.

The volume of hazardous waste generated at LANL is small compared with that at DOE production facilities. Most hazardous wastes are in the form of laboratory chemicals. The liquid, radioactive waste streams that feed the Liquid Waste Treatment Plant contain low concentrations of heavy metals and occasionally some organics. In consonance with OE-AL policy, these streams are treated as radioactive wastes.

Other hazardous or mixed waste treatment/storage/disposal facilities (TSDFs) include the Controlled-Air Incinerator, a chemical storage building, a new batch treatment system, disposal operations in TA-54 Areas G and L, and the explosive area at S-Site where the explosives are burned or detonated.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - MOUND FACILITY
Oak Ridge National Laboratory, August 17, 1984.

The Mound Facility, located in Miamisburg, Ohio, is operated for DOE-ALO by Monsanto Research Corporation (MRC). Mound is an integrated research, development, and production facility performing work in support of DOE weapons and energy programs, with emphasis on explosives and nuclear technology.

Mound generates hazardous wastes in the form of solvents, paints, and thinners; photographic wastes; explosives; chemical laboratory wastes; and spent plating wastes. Mixed wastes are generally from scintillation counting vial wastes.

At the present time, no wastes are disposed of on the Mound site. There is a covered, diked, storage area for hazardous wastes, and a warehouse is used for mixed waste storage and as a staging area for preparing LLRW and TRU wastes for off-site shipment. Mound has a cyclone incinerator and a glass-melter furnace that could be used to treat hazardous and mixed radioactive wastes. Hazardous wastes are packaged and transferred to a commercial disposal firm; nonhazardous solid wastes are handled by a commercial vendor.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - PANTEX PLANT
Oak Ridge National Laboratory, August 16, 1984.

The Pantex Plant, located northeast of Amarillo, Texas, is operated by Mason & Hanger-Silas Mason Company. The primary mission is fabrication of high-explosives (HE) components for nuclear weapons and assembly/disassembly of nuclear weapons systems. Hazardous wastes generated at the Pantex Plant include: (1) HE, (2) PCBs, (3) mercury, (4) asbestos, (5) wastewater, and (6) acids/greases.

Except for neutralization facilities, the only treatment facility at Pantex is the burning ground, located in the northwest section of the plant. HE and HE-contaminated wastes are burned in three separate areas of the burning ground: small dirt-burning pads, a 3-m (10-ft)-diam evaporation/burning tank, and two screened incinerators.

Pantex has no current hazardous waste disposal sites.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - ROCKY FLATS PLANT
Oak Ridge National Laboratory, September 18, 1984.

The Rocky Flats Plant, located northwest of Denver, Colorado, is operated by Rockwell International's North American Space Operations for the DOE. The plant's primary mission is the development and production of certain components for nuclear weapons. These include components fabricated from plutonium, as well as uranium, beryllium, and stainless steel.

Wastes generated at Rocky Flats are categorized as transuranic (TRU) wastes, low-specific-activity (LSA) wastes, and nonradioactive wastes. The majority of wastes generated at Rocky Flats are radioactive or mixed. The small amount of nonradioactive waste generated is sent off-site. Radioactive and mixed wastes are treated on-site to reduce the toxicity and/or volume and then sent to the Nevada Test Site (NTS) for disposal, or to the Idaho National Engineering Laboratory (INEL) for interim storage prior to transfer to the final repository at the Waste Isolation Pilot Plant (WIPP) Facility.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - SANDIA LIVERMORE
Oak Ridge National Laboratory, September 10, 1984.

Sandia National Laboratory's Livermore (SNLL) site, operated by AT&T Technologies for DOE, has as its mission research and development regarding nonnuclear aspects of thermonuclear weapons and advanced alternative energy systems.

SNLL generates virtually no mixed radioactive wastes other than small quantities of acids and waste oils contaminated with tritium from its Tritium Research Facility. Some small quantities of waste PCBs result from old or damaged transformers and capacitors. All radioactive and mixed radioactive wastes are sent to the Nevada Test Site (NTS); commercial disposers are contracted to dispose of the PCBs. Primary wastes generated are small quantities of waste laboratory chemicals. Waste high explosives (HE) components are burned in the SNLL incinerator. Hazardous wastes are shipped off-site to a State of California, EPA-approved, hazardous waste disposal facility. No hazardous wastes are disposed of on-site.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: ALBUQUERQUE OPERATIONS - SANDIA NATIONAL LABORATORY
Oak Ridge National Laboratory, September 10, 1984.

Sandia National Laboratory Albuquerque (SNLA) is a multidisciplinary laboratory engaged in research and development of weapons and alternative energy sources. SNLA is managed by AT&T Technologies for DOE, with substantial work performed for the Department of Defense and Nuclear Regulatory Commission.

SNLA generates quantities of waste laboratory chemicals, photographic wastes, solvents, and some waste lithium batteries and lithium scraps. PCB wastes accumulate from various capacitors and transformers throughout the laboratory. As a tenant on the Kirtland Air Force Base, SNLA must also adhere to certain Air Force waste regulations. Certain waste treatment and disposal activities are shared with the Air Force; for example, the Air Force burns high-explosive wastes, and asbestos is disposed of in the base sanitary landfill. Radioactive mixed wastes at SNLA are treated solely as radioactive wastes and are handled through the radioactive waste disposal program.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: CHICAGO OPERATIONS - ANL-E, FERMILAB, NBL
Oak Ridge National Laboratory, January 23, 1985.

The Argonne National Laboratory-Illinois (ANL-E) performs general basic and applied research and development activities which range over biology, fossil and nuclear energy, particle physics and chemistry. The hazardous waste generation treatment/storage/disposal activities are handled within each division and is supported by the Waste Management Operations Department, which provides overall policy and procedures, collects the packaged wastes, and monitors the commercial shippers activities. The New Brunswick Laboratory (NBL), a government owned - government-operated (GOGO) laboratory, provides measurements of nuclear materials for safeguards inventory verification, methods development, characterization, and preparation of reference materials. All waste types except recoverable uranium scrap and phosphoric acid waste are picked up for processing and disposition by ANL-E. The Fermilab is devoted to the study of high-energy particle physics and generates waste from the fabrication of magnets, some laboratory work, and electrical equipment maintenance and replacement. These wastes are disposed of off-site by commercial disposers.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: IDAHO OPERATIONS - IDAHO NATIONAL ENGINEERING LABORATORY
Oak Ridge National Laboratory, December 12, 1984.

The Idaho National Engineering Laboratory (INEL), located west of Idaho Falls, Idaho, is operated by EG&G Idaho and WINCO.

The INEL facilities generate both hazardous and radioactive mixed waste. The volume of chemical hazardous waste generated at INEL is small, amounting to approximately [1 metric ton (1.0 Mg)]/year of spent organics at WINCO and approximately [10,000 gal (37.8 m^3)]/year of waste oils, solvents, and acids shipped off-site to a commercial waste disposer. Approximately [600,000 gal (2270 m^3)]/year of wastewater containing dilute acids and bases are treated to be made nonhazardous prior to release to infiltration ponds.

The INEL recently initiated an effort to determine its CERCLA situation and is now collecting information to determine the magnitude of its problems.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: NEVADA OPERATIONS - NEVADA TEST SITE
Oak Ridge National Laboratory, December 12, 1984 .

The Nevada Test Site is used for disposal of wastes received from other DOE site operations. Wastes classified as hazardous are shipped to a commercial disposal operation or to reclaiming facilities with a small amount disposed of on-site. As these operations deal with very small volumes, there appear to be few concerns regarding the present management of hazardous or mixed wastes, although a need for waste type evaluation exists.

No treatment or storage facilities are operated on the NTS. Anticipated HCW waste streams from the Tonophah Test Range and Johnston Island will be disposed of in an off-site commercial disposal facility.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - OAK RIDGE ASSOCIATED UNIVERSITIES
Oak Ridge National Laboratory, June 19, 1984.

As a contractor to DOE, Oak Ridge Associated Universities (ORAU) conducts toxicological and biochemical research as part of its overall commitment to the protection of the environment. ORAU is composed of nine separate facilities, four of which are classified as generators of hazardous wastes.

Hazardous waste produced at ORAU consists primarily of miscellaneous laboratory chemicals, including flammables, oxidizers, poisons, toxins, and carcinogens. These chemicals are out of date, no longer required, unlabeled, or have been contaminated. Any analysis required to identify the chemical constituents is conducted at either ORNL, ORGDP, or Y-12. Disposal of these wastes is handled through Rollins Environmental Services, Inc., in Baton Rouge, Louisiana, and ORNL. Radioactive mixed wastes are produced in the form of scintillation vials containing toluene contaminated with low levels of radioactivity (<10 μCi of ^{14}C and ^{3}H per 55-gal drum). The estimated annual generation rate is 30 drums containing approximately 2500 vials each, with the total per drum equaling 276 lb (125 kg). These vials are transported to ORNL for storage.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - OAK RIDGE GASEOUS DIFFUSION PLANT
Oak Ridge National Laboratory, July 17, 1984.

The primary mission of the Oak Ridge Gaseous Diffusion Plant (ORGDP), located west of Oak Ridge, Tennessee, is uranium enrichment as well as research and development work on advanced uranium enrichment technologies.

In the area of hazardous waste management, ORGDP has, or anticipates having, 19 treatment and storage facilities, including 2 TSCA storage areas of PCBs. All disposal of hazardous wastes takes place off-site at EPA-approved commercial disposal sites, or the material remains in storage for future disposal options on-site.

Recent inspections by EPA and the State of Tennessee have emphasized the need to accelerate environmental compliance activities on a more comprehensive basis. The state report on ORGDP, while complimentary of the Environmental Program, recommended that ORGDP's backlog of sludges accumulated by the operation of environmental systems be reduced. The major area of concern at ORGDP is groundwater. Of concern is the area termed "old classified burial ground," for which essentially no records exist to characterize wastes for the appropriate corrective action.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - OAK RIDGE NATIONAL LABORATORY
Oak Ridge National Laboratory, June 19, 1984.

The primary mission of Oak Ridge National Laboratory (ORNL), located south of Oak Ridge, Tennessee, is research and development (R&D) in support of DOE objectives. Major efforts are related to fission and fusion energy, but work is carried out in the physical and life sciences in support of the broader national energy R&D effort. ORNL also does work for other federal agencies and for state and local governments as well as the private sector. ORNL hazardous waste management activities include testing of wastes for hazard class, collection, and preparation of wastes for off-site commercial disposal, on-site disposal of certain wastes, and indefinite storage of radioactive mixed wastes. In 1983, a total of 141,000 kg of chemical or mixed wastes was handled with slightly less than one-half being shipped off-site for commercial disposal.

HWP conclusions regarding potential technology development needs center on the disposal of radioactive mixed wastes and the possibility of remediation at former waste disposal sites subject to CERCLA.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - NLO
Oak Ridge National Laboratory, August 16, 1984.

The Feed Materials Production Center (FMPC), located in southwestern Ohio, is operated by NLO, Inc. It is responsible for purifying and processing uranium metal for use in DOE defense programs. FMPC produces only organic solvents, primarily 1,1,1-trichloroethane, but they maintain an inventory of hazardous wastes received from other sites, including spent trichloride salt, methylene chloride-based degreasing solvent, and uranium-contaminated solvents. The inventory of radioactively contaminated solvents is expected be disposed of in the Toxic Substances Control Act (TSCA) incinerator now under construction at ORGDP, but concern has been expressed as to when the incinerator will be available to incinerate FMPC materials.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - RMI
Oak Ridge National Laboratory, August 9, 1984.

The RMI Extrusion Plant, located in Ashtabula, Ohio, is engaged in an intermediate forming step of both depleted uranium for Savannah River Plant (SRP) and slightly enriched uranium for the N-Reactor at Hanford.

The plant produces approximately 9 tons (~8 Mg) of barium chloride wastes annually from the molten salt baths. This is the primary hazardous waste produced. Approximately two drums of waste solvent are produced each year. Sludges from the nitric acid bath are sent to the Feed Material Production Plant (FMPC) at Fernald for uranium recovery. These sludges may be determined to be hazardous. All hazardous and mixed radioactive wastes are sent to FMPC for final disposition.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: OAK RIDGE OPERATIONS - Y-12 INSTALLATION
Oak Ridge National Laboratory, June 11, 1984.

The Y-12 site, located west of Oak Ridge, Tennessee, has the primary mission of producing nuclear weapon components. They also do production work in support of other DOE facilities and other agencies.

In the area of hazardous waste management, Y-12 operates 26 treatment, storage, and disposal (TSD) facilities and has identified 18 "closed" facilities. They have approximately 150 hazardous or mixed waste streams. Since early 1983, Y-12 has been the subject of intense public scrutiny and regulatory attention with regard to their hazardous waste management practices.

Major areas of concern are as follows: (1) Can the concrete-fixed sludges (primarily from S-3 ponds) be delisted and handled as low-level radioactive wastes? (2) How should other mixed-waste streams be handled? (3) Virtually all of Y-12's current hazardous waste disposal activities must be curtailed or significantly modified. (4) Will funding be available on a timely basis to implement plans for compliance?

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: RICHLAND OPERATIONS
Oak Ridge National Laboratory, July 12, 1984.

The operations at Hanford in support of critical national priorities are many and complex. The major contractors who operate the facility are as follows: (1) Battelle Memorial Institute operates the Pacific Northwest Laboratories (PNL); (2) Westinghouse Hanford Company (WHC) is primarily involved with the development of breeder reactor technology; (3) UNC Nuclear Industries (UNC) operates the N-Reactor; and (4) Rockwell Hanford Operations is responsible for Hanford chemical processing, waste management, and site-support services. Other contractors include: Jones Construction (JAJ), Boeing Computer Services (BCSR), Hanford Environmental Health Foundation (HEHF), and Kaiser Engineers.

Mixed radioactive wastes are the primary problem regarding hazardous chemical wastes and may include high-level and transuranium processing (TRU) wastes. Nonradioactive hazardous wastes generated are reactive metals, PCBs contaminated with slight radioactivity, and laboratory chemicals. Approved chemical analysis capabilities and protocols for waste analysis are needed.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: SAN FRANCISCO OPERATIONS - LAWRENCE LIVERMORE NATIONAL LABORATORY
Oak Ridge National Laboratory, May 3, 1985.

Lawrence Livermore National Laboratory (LLNL), adjacent to Sandia - Livermore National Laboratory, is a multidisciplinary research and development (R&D) DOE laboratory involved in R&D regarding nuclear weapons and advanced energy systems. LLNL is operated by the University of California for DOE's San Francisco Operations Office (SAN).

A few of the major hazardous-waste-producing operations and their wastes are: plating - solvents and rinse waters; printed circuit - metals in rinse waters, acids, (including chromic acid), and solvents; laboratories - waste chemicals; and laser development - potentially carcinogenic dyes. Hazardous wastes are picked up weekly from generators, and all mixed radioactive wastes are properly packaged and shipped to the Nevada Test Site for disposal.

There are on-site disposal facilities at LLNL except for two active landfill operations at Site 300. LLNL operates an incinerator that functions as a disposal method for hazardous and radioactive liquids and solids.

Oak Ridge National Laboratory/Hazardous Waste Program

DOE HAZARDOUS CHEMICAL WASTE SITE VISIT REPORT: SAVANNAH RIVER OPERATIONS - SAVANNAH RIVER PLANT
Oak Ridge National Laboratory, August 13, 1984.

The Savannah River Plant (SRP), located in western South Carolina, had the original mission of producing plutonium and tritium for national defense. That mission has been expanded to include the production of other nuclear materials such as ^{238}Pu, plutonium for cardiac pacemakers and space applications, disposal of radioactive wastes from other federal activities, and recently, reprocessing of naval reactor fuel.

Mixed radioactive wastes are a primary concern requiring resolution by SRP. Organic solvents leaching from seepage basins present a potential problem in maintaining groundwater quality. SRP and SRL staff members are proceeding to develop remedial action plans and technology development programs to isolate, treat, and dispose of organic solvents to eliminate this potential problem. An automated tracking system for hazardous (and mixed radioactive) materials may be of value to SRP in meeting compliance goals. Several technologies developed at SRP (e.g., "StoneCrete" and air stripping of groundwater) warrant further examination for potential extrapolation to other DOE installations.

Oak Ridge National Laboratory/Hazardous Waste Program

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - COMPARISON OF REGULATIONS FOR LOW-LEVEL AND HAZARDOUS WASTE DISPOSAL
Oak Ridge National Laboratory, April 1985.

Regulation of mixed (hazardous and radioactive) waste under the Resource Conservation and Recovery Act (RCRA) and the Atomic Energy Act (AEA) raises issues about consistencies and conflicts between regulations promulgated under the two acts. An analysis of the two sets of regulations has been conducted to identify and analyze the differences between them. Twenty-three specific areas were identified and compared. Six of these areas appear to be in significant conflict; nine differ in a manner which is easily resolved; and eight are in nearly total agreement. The six areas of significant conflict can be attributed to three major differences between the regulations:

1. A difference in regulatory philosophy and approach exists between AEA and RCRA.

2. A difference in strategies for achieving the groundwater protection goals exists between AEA and RCRA.

3. A difference in exemptions provided for Federal facilities exists between AEA and RCRA.

O'Brien, D. E. (Technical Program Chairman)

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 44, pp. 63-68, American Nuclear Society, Inc., June 1983.

Perspectives on Chemical Toxicity in Radioactive Waste includes the following articles:

1. "The NRC Approach to Dealing with Hazardous Substances in Low-Level Radioactive Waste";
2. "Places for the Siting of Low-Level Radioactive Waste: Studies of the Estancia Valley, New Mexico";
3. "Comparative Assessment of Radioactive and Chemically Hazardous Wastes";
4. "Classification of Toxic Chemical Waste Streams from Nuclear Reactors";
5. "Land Disposal of Radioactive Chemicals"; and
6. "Laboratory Procedures for Assessment of Chemical/Physical Toxicity Parameters in Low-Level Radioactive Waste."

Other articles listed in this volume are included in the following abstract.

O'Brien, D. E.

TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY
Vol. 44, pp. 433-42, American Nuclear Society, Inc., June 1983.

New Strategies for Low-Level Waste Management includes the following articles:

1. "Evaluation of a Shredder/Compactor for DAW Treatment";
2. "Incineration of Ion-Exchange Resins Using a Cocentric Burner";
3. "Recent Experience: Processing Radioactive Steam Generator Decontamination Grit for Disposal";
4. "Progress Report: Steam Generator Secondary-Side Chemical Cleaning Waste Treatment";
5. "Development of an Electrolytic Decontamination Technique Using a Dilute Sulfuric Acid Electrolyte";
6. "Use of Fluidized-Bed Technology for Low-Level Waste Management";
7. "Liquid Abrasive Decontamination Operating Experience"; and
8. "Fort Calhoun Spent Fuel Pool Cleanup Following a Spill of Hydraulic Fluid Containing Glycol."

Office of Technology Assessment

NONNUCLEAR INDUSTRIAL HAZARDOUS WASTE
Congress of the United States, November 1981.

As a means of providing a basis of understanding the degree-of-hazard concept and potential benefits as well as anticipated problems, this paper discusses the following:

1. basic issues surrounding a degree-of-hazard classification approach,
2. the potential for incorporating a degree-of-hazard concept through classification in current regulations,
3. various methods for applying a degree-of-hazard classification system, and
4. some questions to be addressed before the decision concerning whether or not to select and incorporate a degree-of-hazard classification system at the federal and state level can be made.

Ohrn, G.

INCINERATION OF LOW-LEVEL DAW - OPERATING EXPERIENCE AT STUDSVIK, SWEDEN
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. J1 to J23, March 1985.

Studsvik operates a central incinerator facility serving 25 nuclear waste generating customers in Sweden and Germany. The plant is operating at a current capacity of 425 metric tons (Mg) of DAW incineration per year. Operating experience dates from 1976, and the cumulative total of waste incinerated amounts to about 2000 metric tons (Mg), which is roughly equivalent to 20,000 m^3 of unprocessed waste. The plant has operated with a 95% availability factor since commissioning. Technical details of the incinerator system, operational characteristics, and operational experience are discussed.

O'Leary, D. T.; et al.

METHODOLOGY FOR ESTIMATING ENVIRONMENTAL LOADINGS FROM MANUFACTURE OF SYNTHETIC ORGANIC CHEMICALS
EPA-600/S3-83-064, Environmental Protection Agency, November 1983.

A methodology was developed for estimating the multimedia environmental loadings for a "new" chemical in the absence of manufacturing plant emissions data. This methodology draws on a multimedia environmental release data base (ERDB) that contains information about structurally similar compounds which undergo similar process (physical and chemical) unit operations. The ERDB is integrated with other pertinent available data on the manufacturing process of the new chemical, such as: (1) physical and chemical properties of process feedstock, products, and by-products; (2) reaction stoichiometry, thermodynamics, and reaction kinetics; (3) process flow diagram and process mass balance; (4) location and composition of environmental releases and method of disposal; (5) process environmental control technology (including performance); (6) process storage and handling requirements; and (7) plant equipment components (in numbers and classes).

An example is provided to demonstrate the applicability of the methodology.

Ollig, R.; Randl, R.

OVERVIEW OF REPROCESSING AND WASTE MANAGEMENT IN THE FEDERAL REPUBLIC OF GERMANY
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 46-50, August 26-29, 1984.

This paper looks back on the past years of waste management in the Federal Republic of Germany:

1. to evaluate what has been used as backup services for German nuclear power stations, and
2. to assess what the coming years will bring.

Ontario Waste Management Corporation

FACILITIES DEVELOPMENT PROCESS - PHASE 1 REPORT
Ontario Waste Management Corporation, September 1982.

This report summarizes the key information and issues contained in studies recently completed for the Ontario Waste Management Corporation (OWMC). The completion of these studies marks the end of the first phase of OWMC's planning program - called the Facilities Development Process - which is designed to develop proposals for a province-wide industrial waste management system. While each study is different in scope and subject, they all stem from the need to examine several basic issues: (1) what are the types, quantities, and sources of liquid industrial waste and hazardous waste generated in Ontario; (2) how can this material be safely and efficiently treated and disposed of; (3) what are the key issues that must be addressed in choosing the treatment and disposal facilities required; and (4) where should they be located? It is not the purpose of this report to identify specific sites. They cannot be identified until the results of these studies have been evaluated in more detail. This report is designed to link together the key findings of the studies (Chapters 2 to 4), to define their relevance to possible system options (Chapter 5), and to describe the issues that must be addressed (Chapter 6).

Ontario Waste Management Corporation

FACILITIES DEVELOPMENT PROCESS - PHASE 3 REPORT
Ontario Waste Management Corporation, March 1984.

This report completes the third phase of the Ontario Waste Management Corporation's Facilities Development Process, which is designed to develop proposals for a province-wide industrial waste management system. The specific purpose of this third phase was to select candidate sites which will be studied in detail as possible locations for OWMC's treatment and disposal facilities. These sites, located within the Golden Horseshoe, are described in Chapter 6 of this report.

Ontario Waste Management Corporation

FACILITIES DEVELOPMENT PROCESS - APPENDIX TO THE PHASE 3 REPORT
Ontario Waste Management Corporation, March 1984.

The materials in this appendix volume accompany the OWMC Phase 3 Report, which was released in March 1984. The organization of the text and tables mirrors that of the Phase 3 Report, with the supporting technical information for each section of the report segregated for easy reference.

This volume is intended to be used in reference to the Phase 3 Report. Additional, lengthy technical reports detailing the data and methodologies applied in reaching Phase 3 candidate site decisions are being completed and will be available from OWMC.

Ontario Waste Management Corporation

WASTE REDUCTION OPPPORTUNITIES STUDY
Proctor and Redfern Group, Ontario Waste Managment Corporation, May 1983.

This study has been undertaken for the Ontario Waste Management Corporation (OWMC) with four major objectives:

1. to assemble data on what steps are already being undertaken by Ontario industry to reduce the quantity of waste requiring treatment and disposal;
2. to assess, in qualitative terms, the impact waste reduction initiatives would have on the quantity and nature of waste;
3. to survey other jurisdictions to ascertain what role organizations, similar in structure and mandate to OWMC, are playing to encourage waste reduction; and
4. to suggest potentially useful roles which OWMC might consider assuming in order to encourage waste reduction in Ontario.

Orlett, M. J.

THE USE AND REGENERATION OF ACTIVATED ALUMINA IN THE RESTORATION OF DETERIORATED LUBE OIL
GAT-T-2247, Goodyear Atomic Corporation, November 11, 1974.

Continuing and accelerating deterioration of the lube oil in the Portsmouth Diffusion Plant's process systems has led to a restoration program for the oil using fuller's earth. Laboratory data are presented showing some distinct advantages, chiefly the ability to be regenerated, of activated alumina over fuller's earth for this program. It is recommended that enough activated alumina be obtained to evaluate the material in our present cascade filtering system and, upon the completion of a successful initial run, that minor modifications be made to the filter to permit regeneration of the alumina in place.

Orvis, D. D.; Johnson, C.; Jones, R.

REVIEW OF PROPOSED DRY-STORAGE CONCEPTS USING PROBABILISTIC RISK ASSESSMENT
EPRI-NP-3365, Electric Power Research Institute, February 1984.

The methods of probabilistic risk assessment (PRA) are applied to assess the relative public risk associated with four alternative storage concepts for spent reactor fuel. These alternatives include a reference pool storage facility and three dry-storage schemes: (1) cask, (2) caisson (dry-well), and (3) vault. These concepts are under consideration as means to increase the on-site storage capacity of reactor power plants as an alternative to off-site shipment to a storage or reprocessing facility.

The analysis compares frequency versus consequence envelopes based on a wide spectrum of accident scenarios from handling and transport accidents to external events such as earthquakes. The principal observation is that none of the dry-storage concepts appears to exhibit any significant advantage over the other with respect to maximum risk. However, the pool concept appears to pose somewhat greater risk than any of the dry-storage concepts. The accident analyses indicate that handling and on-site transport operations yield the highest risk and that the risk is comparable for all concepts.

Osmeyer, W. E.

OPERATIONAL COST COMPARISONS FOR VARIOUS RADWASTE DISPOSAL TECHNIQUES
American Nuclear Society/European Nuclear Society International Conference, November 1980.

This paper attempts to parametrically explore the factors that influence the operational costs of radwaste disposal by evaluating process techniques, radwaste binder materials, and radiation burial surcharges which are very influential on the overall operating cost evaluation.

The techniques addressed in this paper are solidification of radwaste with: (1) no volume reduction, (2) volume reduction by evaporation, and (3) volume reduction by incineration. The types of radwaste evaluated are: (1) boric acid, (2) resins, (3) oils, and (4) dry wastes. The solidification binders evaluated are: (1) asphalt, (2) cement, (3) polymers, (4) U-Form, a urea-formaldehyde; and (5) glass. Some binder materials and techniques such as ash compaction and protective coatings or new thermosetting resins and plastics, could not be evaluated due to their proprietary nature and the associated lack of performance data in the open literature.

Oyen, L. C.; Tucker, R. F., Jr.

ADVANCED LOW-LEVEL RADWASTE TREATMENT SYSTEMS
EPRI-NP-1600, Sargent and Lundy, October 1980.

A survey of the present status of commercial radwaste volume reduction (VR) activity in the United States is presented. Volume reduction is defined, and a set of categories for VR processes is given, namely (1) crystallization, (2) dehydration, (3) compaction, and (4) incineration. Some examples of the effects of these processes are given, and their realms of applicability are illustrated. A "typical" economic assessment is given with methods and assumptions stated in detail, showing conditions under which VR equipment can be cost-effective. System descriptions are given for nine currently, and four potentially, commercially available VR systems.

The types of systems treated include evaporative crystallizers, both forced circulation and thin-film types; fluidized-bed dryers; bitumen dryer and solidification systems; a blender/evaporator dryer; an inert carrier evaporator-dryer; and fluidized-bed incinerators, controlled-air incinerators, and excess-air, solid-bed incinerators, as well as a glass furnace used as an incinerator/calciner.

Oyen, L. C.; Tucker, R. F., Jr.

NON-U.S. ADVANCED, LOW-LEVEL, RADWASTE-TREATMENT SYSTEMS
EPRI-NP-2055, Sargent and Lundy, September 1981.

This report is the second of a series of interim reports which will be issued at approximately 6-month intervals for the duration of the study; the final report is due in April 1983. In addition to a review of the available English language literature, visits were made to power plants and research centers in Europe and Japan and to private and government agencies in Korea.

The nuclear research centers and power plants that were visited in Japan made use of volume reduction (VR) techniques and on-site storage facilities. Volume reduction techniques are in use at the two major nuclear research centers in West Germany, and several power plants have made plans to use VR systems. Research on leaching was also being carried out in Japan. Information concerning the VR systems in Canada is based on a trip to the Bruce Nuclear Power Development Station in 1977 and on reports and personal communications with Ontario Hydro engineers.

Work on radwaste VR systems and incinerators in the United States is updated, along with other events concerning VR systems.

Pagano, R.; Leslie, M.; Douglas, R.

MONITORING THE AQUATIC ENVIRONMENT AT STEAM-ELECTRIC POWER PLANTS
MTR-7974, The MITRE Corporation, March 1979.

A review of U.S. experience in monitoring the effects of steam-electric power plants on the aquatic environment indicates that recent legislation has influenced several aspects of monitoring. A substantive body of knowledge acquired through monitoring has led to the broadly accepted finding that the rejection of waste heat has generally given rise to little detrimental effect. Concern now focuses on the entrainment and impingement of aquatic organisms and on the release of toxic substances from power plants. It may be anticipated that ongoing developments in monitoring will continue to reflect these concerns.

Pajak, A. P.; Shuckrow, A. J.; Robb, A. E.

GROUNDWATER TREATMENT: STATE OF THE ART
Hazardous Materials '84, Michael Baker, Jr., Inc., June 1984.

This paper attempts to provide a summary which describes groundwater treatment technologies that have been applied at problem sites. That is, the focus is on technologies used and judged to be effective. Numerous cases of contaminated groundwater treatment are briefly reviewed; these cases cover a typical range of conditions, chemical constituents, and problem magnitudes. Where possible, both economic information and performance results are presented.

Palino, G. F.; Liang, T. J.; Light, W. G.; Kubarewicz, J. W.

AN APPLICATION OF ULTRAFILTRATION TO RADWASTE
EPRI-NP-2335, NWT Corporation, April 1982.

Considerable concern has been expressed by utility personnel regarding the advisability of applying membrane filters to radwaste environments. This project demonstrated satisfactory UF membrane performance over an extended period of time in a radwaste application. The performance of the system was characterized, and a detailed evaluation was made of the impact on the radwaste system. Very little change was seen in the performance of an evaporator, downstream of the UF system. However, the records clearly demonstrate a significant reduction in evaporator maintenance-associated exposure. Finally, caution must be exercised in applying the UF decontamination factors (DFs). Two such factors are referred to - "membrane DF" and "system DF." Only the UF system DF has significance in evaluating removal within the radwaste system. This factor reflects the ratio between impurities in the input stream and those in the effluent stream. Membrane DF refers to the recirculating concentrated solution impurities and the effluent stream. High-membrane DFs do not ensure removal across the UF system. Considerable data are presented regarding the performance and impact of a UF system applied to PWR radwaste processing.

Patterson, J. W.; Minear, R. A.

STATE OF THE ART FOR THE INORGANIC CHEMICALS INDUSTRY: CHEMICAL EXPLOSIVES
EPA-600/2-74-009b, Environmental Protection Agency, March 1975.

A literature and field study of the commercial explosives industry reveals that, on the basis of products manufactured, plant size, and the nature of the wastewater, the industry may be divided into three segments. The first category is complex facilities, which are large plants manufacturing a variety of explosives and intermediate products. The second category is small, specialized formulation plants, typically limited to blending explosives formulations for use in nearby mining activities. The final category is specialty product facilities, which are devoted to the manufacture of select ingredients such as lead azide and other explosives initiators, blasting caps, electric matches, and similar appurtenance items. The explosives industry discharges large volumes of wastewater, typically high in BOD, nitrogen, and solids, frequently at extreme pH, and containing trace to high quantities of dissolved and particulate explosives products. Although pollution abatement technology has not been widely implemented within the explosives industry, there is potential for significant abatement of pollutant discharge by good housekeeping practices, application of proven treatment technology, and, under certain conditions, total wastewater containment.

Patterson, J.; Shapira, N. I.; et al.

STATE OF THE ART MILITARY EXPLOSIVES AND PROPELLANTS PRODUCTION INDUSTRY - VOLUME I - THE MILITARY EXPLOSIVES AND PROPELLANTS INDUSTRY
EPA-600/2-76-213A, Project No. 802872, Environmental Protection Agency, October 1976.

This study, contained in three volumes, addresses the wastewater effluents of the military explosives and propellants production industry. Both manufacturing and LAP (load, assemble, and pack) activities are covered. Volume I describes the industry, as well as the production processes and technology.

A comprehensive long-term effort has been under way by the Department of Defense for a number of years for the purpose of modernizing munitions production plants. Pollution abatement is an integral part of the modernization program. Although extensive study, research, and development investigations have been undertaken, and although significant water pollution abatement and water management plans have been developed, implementation is generally in only the initial stages at selected military facilities. Major government emphasis and very substantial funding are essential to: (1) the continuation of necessary pollution abatement research and development, (2) the demonstration of promising new treatment technologies, and (3) the implementation of effective and economical treatment system construction programs. Recommendations are set forth.

Patterson, J.; Shapira, N. I.; et al.

STATE OF THE ART: MILITARY EXPLOSIVES AND PROPELLANTS PRODUCTION INDUSTRY - VOLUME II - WASTEWATER CHARACTERIZATION
EPA-600/2-76-213B, Environmental Protection Agency, August 1976.

This study has surveyed the military explosives and propellant manufacturing industry, covering both "GOGO" and GOCO" facilities. Sources of wastewater, volumes, and pollutant constitutents have been reported where such data existed.

Treatment technology currently in use at the various installations has been described, including the effectiveness of pollutant removal and secondary (air and solid) waste generation. Systems under development at these military installations have also been examined and evaluated in light of available information.

The report consists of three volumes. Volume II presents the bulk of the data concerning the wastewaters and the treatment systems now in place.

Patterson, J.; Shapira, N. I.; et al.

STATE OF THE ART: MILITARY EXPLOSIVES AND PROPELLANTS PRODUCTION INDUSTRY - VOLUME III - WASTEWATER TREATMENT
EPA-600/2-76-213C, Environmental Protection Agency, October 1976.

This study, contained in three volumes, addresses the wastewater effluents of the military explosives and propellants production industry. Both manufacturing and LAP (load, assemble, and pack) activities are covered. Volume III describes and evaluates the effectiveness of various treatment technologies for water pollution abatement now in use or under investigation by product, process, and military installation.

A comprehensive long-term effort has been under way by the Department of Defense for a number of years for the purpose of modernizing munitions production plants. Pollution abatement is an integral part of the modernization program. Although extensive study, research, and development investigations have been undertaken, and although significant water pollution abatement and water management plans have been developed, the demonstration of promising new treatment technologies, and the implementation of effective and economical treatment system construction programs are only in the initial stages at selected military facilities.

Pavelek, I. I.; Carmel, P. G.

VOLUME REDUCTION OF CONTAMINATED CONCRETE SHIELD SLABS THROUGH SURFACE REMOVAL
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 303-7, March 1985.

During the TMI accident, large areas of concrete surfaces were contaminated. Both unprotected concrete and concrete under protective coatings were affected. This paper describes the approach used to achieve both effective decontamination and significant radwaste volume reduction during the cleanup of 16 concrete shield slabs. The cost-benefit analysis leading to the decision to mechanically decontaminate rather than dispose of the complete slabs is discussed. Scabbling (mechanical removal of a thin surface layer of concrete) from approximately 2000 ft^2 (186 m^2) of surface is described, including the various equipment and methods used. Finally, the resulting post-decontamination, the contamination levels, the waste volumes created, and the waste collection and disposal methods are discussed.

Piasecki, B.; Davis, G. A.

A GRAND TOUR OF EUROPE'S HAZARDOUS-WASTE FACILITIES
Technology Review, pp. 20-29, July 1984.

The hazardous waste facilities in some European countries resemble chemical plants rather than the landfills found in America. Over 10 years ago, land-conscious Europeans decided that dumping chemical garbage on, or into, the ground is neither safe nor economical. Instead, several countries developed management systems designed to reduce the amount of toxic wastes generated and to use modern chemical technologies and high-temperature incinerators to recycle waste and minimize the need for dumping. The rotary-kiln incinerator is the workhorse of most European treatment plants, destroying organic wastes at temperatures in excess of 1200°C with an efficiency of 99.9999%. In several European countries, there has been a creative combination of private and public enterprise that manages toxic wastes with a minimum of expense and red tape. West Germany and Denmark lead the way in waste management. Sixty percent of West Germany's toxic wastes are detoxified instead of being dumped. In Denmark, where 98% of the nation's drinking water comes from groundwater, virtually no untreated chemical wastes are disposed of on land. Instead, treatment technologies destroy or detoxify practically all of that country's most threatening waste.

Piciulo, P. L.; Adams, J. W.

RELEASE OF ORGANIC REAGENTS FROM SOLIDIFIED DECONTAMINATION WASTES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 257-61, March 1985.

In order to provide technical information needed by the U.S. Nuclear Regulatory Commission to evaluate the adequacy of near-surface disposal of decontamination wastes, Brookhaven National Laboratory has measured the release of organic reagents from solidified simulated decontamination wastes. The waste streams consisted of either mixed-bed ion-exchange resins or anion exchange resins equilibrated with EDTA, oxalic acid, citric acid, picolinic acid, or simulated LOMI decontamination reagent. These simulated resin wastes were solidified in either cement or vinyl ester — styrene. Samples were tested by a fixed-interval leach procedure or according to the standard ANS 16.1 procedure. The leachability indices, which were calculated as prescribed in ANS 16.1, varied with the leach period for some of the composites tested.

Pitchford, T. L.; et al.

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT AT THE UNIVERSITY OF MISSOURI
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. R1 to R7, March 1985.

The University of Missouri uses by-product material at four widely separated campuses, at a research reactor, and at locations elsewhere in the state. Coordination of the radiation control program is accomplished by the central Office of Research Safety. For reasons of economy, the management of the radioactive waste program has become partly centralized. Some wastes generated by the Research Reactor Facility and nearly all the wastes generated at three of the four campuses are collected, evaluated, and separated by each of the respective health physics organizations. The waste separation categories are: (1) materials that may be disposed of locally, (2) material that should be held for decay prior to any processing, (3) material that may be incinerated, and (4) material that must be shipped to a licensed burial site. This paper describes the organizational coordination and the specific procedures that are employed for processing the waste for incineration.

Pitt, W. W.; Hancher, C. W.; Patton, B. D.

BIOLOGICAL REDUCTION OF NITRATES IN WASTEWATERS FROM NUCLEAR PROCESSING USING A FLUIDIZED-BED BIOREACTOR
Nuclear and Chemical Waste Management, Vol. 2, pp. 57-70, 1981.

There are a number of nitrate-containing wastewater sources, as concentrated as 30 wt % NO_3^- and as large as 2000 m^3/d, in the nuclear fuel cycle. The biological reduction of nitrate in wastewater to gaseous nitrogen, accompanied by the oxidation of a nutrient carbon source to gaseous carbon dioxide, is an ecologically sound and cost-effective method of treating wastewaters containing nitrates. These nitrate-containing wastewater sources can be successfully biologically denitrified to meet discharge standards in the range of 10 to 20 g of N $(NO_3^-)/m^3$ by the use of a fluidized-bed bioreactor. The denitrification bacteria are a mixed culture derived from garden soil; the major strain is Pseudomonas. This paper describes the results of a biodenitrification research and development program based on the use of fluidized bioreactors capable of operating at nitrate levels up to 7000 g/m^3 and achieving denitrification rates as high as 80 g $N(NO_3^-)$ per day per liter of empty bioreactor volume.

Poor, N. D.; Hertel, N. E.

A COMPARISON OF LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 119-22, March 1985.

The selection of a low-level radioactive waste management alternative by a state or regional compact will be based on the ability of the alternative to meet the required performance objectives of 10 CFR Part 61 within the constraints of political acceptability, economic feasibility, and site-specific characteristics such as geology and hydrology. This paper presents an effort to organize available information for comparison of land utilization, occupational radiological hazard, and cost between and among conventional shallow-land disposal facilities, disposal facilities which stabilize waste with grout, and storage facilities using engineered structures.

Post, R. G. (General Chairman and Editor)

THE APPLICATION OF NUCLEAR WASTE MANAGEMENT TECHNIQUES AND SYSTEMS TO NONRADIOACTIVE HAZARDOUS WASTE MANAGEMENT. VOLUME 1. Waste Management '82, Proceedings of the Symposium on Waste Management at Tucson, Arizona, CONF-820303, March 1982.

Chemical Waste/Nuclear Waste Disposal--Is There A Difference? - pp. 175-83.

A Bioethical Perspective on Risk Assessment Models for Managing Toxic Wastes, Radioactive or Nonradioactive - pp. 191-202.

An Integral Risk Assessment Model for Hazardous Wastes - pp. 203-19.

Post, R. G. (Editor); Wacks, M. E. (Technical Program Chairman)

WASTE MANAGEMENT '85 - WASTE ISOLATION IN THE U.S. TECHNICAL PROGRAMS AND PUBLIC EDUCATION. VOLUME 2 - LOW-LEVEL WASTE Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, CONF-850314, March 1985.

The following papers were presented:

1. State and Regional Policies and Programs for Low-Level Radioactive Waste - 5 papers.
2. Technical and Economic Considerations in LLRW Disposal - 6 papers.
3. Toxic and Low-Level Radioactive Mixed Wastes: Institutional and Technical Considerations - 9 papers.
4. Alternative Methodologies in LLRW Disposal - 8 papers.
5. Poster - Low-Level Radioactive Waste Processing and Burial Factors - 19 papers.
6. Poster - TMI and Radiation Protection - 21 papers.
7. Methods for Minimization of Radwaste at the Source - 6 papers.
8. Radwaste System Modifications - 7 papers.
9. Hydrofracture and Grout Techniques - 8 papers.
10. Volume Reduction Operating Experience: Dry Active Waste - 6 papers.
11. Volume Reduction Operating Experience: Liquid Waste - 7 papers.
12. Secondary Wastes and Sludge - 5 papers.

Post, R. G. (Editor); Wacks, M. E. (Technical Program Chairman)

WASTE MANAGEMENT '85 - WASTE ISOLATION IN THE U.S. TECHNICAL PROGRAMS AND PUBLIC EDUCATION. VOLUME 3 - GENERAL INTEREST.
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, CONF-850314, March 1985.

The following papers were presented:

1. Special Presentation by Chairman Post - 1 paper.
2. Institutional Interactions: The Agreements Process - 8 papers.
3. Workshop on Environmental Assessments and EIS - 6 papers.
4. Social and Economic Effects of Public Perceptions - 5 papers.
5. Siting Impacts - 8 papers.
6. Remedial Actions: Fact Not Fiction - 6 papers.
7. Release and Transport of Radionuclides from Disposal Systems - 9 papers.
8. Packaging and Transportation - 8 papers.
9. Poster - Packaging, Transportation and Disposal - 20 papers.
10. Decommissioning/Decontamination - 6 papers.
11. Poster - Nuclear Waste Disposal - 21 papers.
12. List of Attendees.

The Proctor & Redfern Group

BACKGROUND PAPER - WASTE REDUCTION
Proctor & Redfern Group, Ontario Waste Management Corporation, July 1982.

This report discusses the desirability of waste reduction as a waste management technique, particularly as it applies to the development of a waste treatment and disposal system, and identifies potential roles for OWMC to consider in encouraging waste reduction and recovery practices in Ontario.

A number of successful waste reduction and recovery practices in several key industries are reviewed, along with a brief examination of current waste reduction and recovery activities in Ontario, including the Canadian Waste Materials Exchange Program.

A preliminary assessment of recycle/reuse possibilities for various types of wastes is given, using the waste categorization system developed by the University of California at Davis (UCD) to identify the waste streams considered.

The Proctor & Redfern Group

PRIMARY INFORMATION - ENGINEERING INFRASTRUCTURE
Proctor & Redfern Group, Ontario Waste Management Corporation, August 1982.

The engineering infrastructure requirements for waste treatment/disposal facilities can readily be provided for electrical power, transportation, fuel, water, and storm sewerage. However, the requirements for the assimilation of aqueous effluents and gaseous emissions from the treatment process will create certain constraints on site selection. It is anticipated that, notwithstanding the advanced level of treatment that will be provided for liquid wastes and sidestreams, dilution and further treatment in a municipal wastewater treatment plant would be a benefit; hence, not only will backup treatment be provided, but facility location in close proximity to a large receiving body of water will not be essential. Alternatively, direct discharge, after treatment, to a surface body of water is a possibility that will be evaluated. The effect of stack emissions on existing and future adjacent land use is a major consideration in siting a waste treatment facility that includes incineration as a treatment option. The impingement concentrations must be carefully evaluated, taking into consideration stack height, land use, and separation distance prior to determining the suitability of potential sites.

The Proctor & Redfern Group

PRIMARY INFORMATION - LAND USE
Proctor & Redfern Group, Ontario Waste Managment Corporation, August 1982.

As part of the collection of background data for the waste management facilities development process, a considerable inventory of land use-related factors has been assembled. This inventory represents a data bank from which the impacts that may be expected from a proposed facility can be determined.

The information is also useful as a basis to identify characteristics that will be encountered in any particular area. The presentation of these characteristics is best approached at the general level by dividing southern Ontario into a number of broad regions within each of which there are sets of characteristics that bear on questions of site selection in related ways.

The purpose of this report is to summarize the characteristics of each region, relate them to the facilities development process, and draw the relevant conclusions for assisting in the selection of the appropriate facilities system.

Raber, E.; Carpenter, D. W.

AN EVALUATION OF THE HYDROGEOLOGY AND GROUNDWATER CHEMISTRY ASSOCIATED WITH LANDFILLS AT LLNL'S SITE 300
UCRL-53416, Lawrence Livermore National Laboratory, June 1983.

Staff personnel at LLNL have completed an assessment of potential groundwater contamination from eight solid waste landfills within LLNL's Site 300. Investigations included extensive geological, hydrological, geophysical, geochemical studies directed toward an evaluation of hydrogeology and groundwater chemistry in the vicinity of the landfill locations. A state-of-the-art groundwater sampling system was installed, which allows for collection of samples and piezometric measurements from discrete isolated sampling zones. Installations were made in 8 of the 17 boreholes completed for groundwater sampling to permit analysis of deeper aquifers, as well as the uppermost water-bearing zone. To prevent cross-contamination between aquifers during drilling, an aquifer isolation technique was developed. Special precautions were taken in drilling and well completion procedures to minimize the introduction of contaminants. Three separate sets of hydrological measurements and chemical analyses were made to identify the direction of groundwater flow from the landfill and to establish whether any contaminants had been introduced into the groundwater. No excess contamination levels were found.

Radimsky, P. E.; Bogg, R; Daniels, D.; Eriksson, M. R.; et al.

ALTERNATIVE TECHNOLOGY FOR RECYCLING AND TREATMENT OF HAZARDOUS WASTES
Second Biennial Report, Department of Health Services, State of California, July 1984.

Technologies included in this report are grouped according to the waste streams for which they are applicable. Technologies for treating inorganic wastes, including acid, dissolved metal, and cyanide wastes are presented in Part I of this report (Chapters 1-3). Technologies for organic wastes, including polychlorinated biphenyls and incinerable and non-incinerable wastes, are presented in Part II (Chapters 4-7).

The diversity of wastes considered in this report requires that each chapter include background information on each waste stream, regulations which motivate treatment of the specific waste, and alternative technologies available for managing the particular waste stream. Available recycling technologies, as well as promising and emerging technologies, are also discussed where appropriate.

Rasmussen, G. A.

RECYCLE OPERATIONS AS A METHODOLOGY FOR RADIOACTIVE WASTE VOLUME REDUCTION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 1, pp. 165-69, March 1985.

The costs for packaging, transportation, and burial of low-level radioactive metallic waste have become so expensive that an alternative method of decontamination for volume reduction prior to disposal can now be justified. The operation of a large-scale, centralized recycle center for decontamination of selected low-level radioactive waste has proven to be an effective method for waste volume reduction and for retrieving valuable materials for unlimited use.

The centralized recycle concept allows application of state-of-the-art decontamination technology, resulting in a reduction in utility disposal costs and a reduction in overall net amount of material being buried. Examples of specific decontamination process activities at the centralized facility will be reviewed, along with a discussion of the economic impact of decontamination for recycling and volume reduction. Based on almost 2 years of operation of a centralized decontamination facility, a demonstrated capability exists. The concept has been cost-effective and proves that valuable resources can be recycled.

Reactor Radwaste Management Workshop

REACTOR RADWASTE MANAGEMENT WORKSHOP, NEW ORLEANS, LOUISIANA
Reactor Radwaste Management Workshop, CONF-770120, January 1977.

The proceedings of the Reactor Radwaste Management Workshop, held in New Orleans, Louisiana, on January 12–14, 1977, includes the general papers and the summaries of workshop sessions and discussions. Four special workshops were held: Volume Reduction; Solidification; Physical and Chemical Separations; and Corrosion, Decontamination, and Retrofitting. Each workshop included an open and thorough discussion of radwste treatment technologies, problem areas, and development needs. The proceedings, issued in draft form, were compiled by H. W. Godbee and A. H. Kibbey, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.

Rickman, W. S.

CIRCULATING-BED INCINERATION OF RADIOACTIVE AND HAZARDOUS WASTES
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. N1 to N12, March 1985.

Recent operating experience on circulating-bed waste incinerators has demonstrated clean, efficient, and economical treatment of a variety of low-level radwastes. Wastes being processed today include: (1) granular carbon with heavy-metal chlorides, (2) uranium-bearing oil sludge, and (3) chunks of graphite containing fission product waste. These and other wastes are classified and regulated now by both the EPA and the NRC, with a much tighter set of regulations than ever before. GA's circulating-bed waste incinerator systems have received all permits based on their demonstrated ability to: (1) destroy hazardous constituents to >99.999% efficiency - without afterburners or auxiliary fuel, (2) retain >99% of all HCl emissions - without wet scrubbers, and (3) meet all EPA and NRC particulate emission standards using dry filters that are continuously cleaned on-line. Photographs and cutaway drawings of several of the over 25 current installations are presented, along with specific operational performance data.

Rickman, W. S.; Holder, N. D.; Young, D. T.

CIRCULATING-BED INCINERATION OF HAZARDOUS WASTES
Chemical Engineering Progress, Vol. 81, No. 3, pp. 34-38, March 1985.

Circulating-bed waste incinerators operate cleanly, efficiently, and economically. Their simple design uses high turbulence in the reaction zone to eliminate afterburners, scrubbers, or multiple feeders. Proven performance on industrial wastes includes the following benefits:

1. combustion efficiency, >99.999%;
2. HCl capture, >99%;
3. no scrubbers or wet sludge product;
4. no afterburners or auxiliary fuel;
5. highest boiler efficiency in industry;
6. waste volume reduction up to 40:1;
7. recovery of valuable chemicals;
8. single-point feeding, even up to 100 million Btu/h (35 MW, thermal); and
9. NO_x and CO emissions, <100 ppm (100 mg/L).

Rickman, W. S.; Holder, N. D; Young, D. T.

CIRCULATING-BED INCINERATION OF HAZARDOUS WASTES
Presented at American Institute of Chemical Engineers 1984 Summer National Meeting, GA Technologies, August 1984.

Across the nation, landfills and deep-well injection appear to be on their way out as acceptable methods for hazardous waste disposal. Several recent studies of industrial waste management in the United States have pointed out the need for more vigorous development of alternatives. An alternative to simple disposal of wastes is treatment. For many waste types, incineration is the best treatment method. In a well-designed incineration system, the following benefits should be realized:

1. destruction of hazardous compounds;
2. retention of acid gases, such as HCl;
3. reduction of volume;
4. recovery of heat; and
5. recovery of valuable chemicals.

This paper describes circulating-bed incineration, an advanced type of incinerating proven to meet all of these criteria with a simple, effective design.

Ritchie, J.; Allan, G.

RADWASTE DRYING: AN ENGINEERED SYSTEM FOR POWDERED AND GRANULAR MEDIA
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 217-25, March 1985.

Low-level ion exchange resins, filter media, and sludges are currently dewatered or solidified prior to disposal. A waste drying system that fully meets the regulatory requirements regarding freestanding water in less than 8 h with more volume-efficient containers has been placed in commercial service. The large increase in drying performance results from an engineered approach to the problem. Waste characteristics, waste container design, and thermal effects were reduced to an analytic model with specific end points and proven with fixed tests and field operations. Not only can the amount of freestanding water be predicted, but zero freestanding water criteria can be confidently achieved. A patent is pending on the process and many specific aspects of the system.

Roberts, A. (Project Manager)

UPDATED COSTS FOR DECOMMISSIONING NUCLEAR POWER FACILTIES
EPRI-NP-4012, Battelle, Pacific Northwest Laboratories, May 1985.

This update of 1978 NRC cost estimates (in 1984 dollars) also estimates the costs of several special manpower and licensing options for decommissioning nuclear power facilities. The fully developed methodology offers utilties a sound basis on which to estimate the costs of decommissioning specific plants.

The estimates developed in this study, ranging between $65.5 million and $123.4 million, are consistent with the $100 million level on which NRC bases it rulings. Recognizing that these costs are generic, however, facility owners must take site-specific factors into account in preparing individual estimates. The industry has a much better understanding of decommissioning costs today than it had in 1978, and the procedures for estimating those costs have evolved to the point at which their completeness is ensured. The comprehensive methodology developed in this study should therefore provide a sound basis for such individual estimates.

Rochester, D. P.

TESTING AND OPERATION OF A TRANSPORTABLE VOLUME REDUCTION UNIT
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 385-86, March 1985.

In order to process the high-volume, low-specific-activity liquid radwaste from the chemical cleaning of the Oconee Nuclear Station steam generators, Duke Power Company purchased a transportable volume reduction (TVR) system from Associated Technologies, Inc. Before the unit could be operated at Oconee, the system had to be functionally tested, the process optimized, and simulated waste streams processed to ensure that the end product would meet burial-site requirements. Although the primary objective of the unit was to process the spent cleaning solvent, the scope of the testing was expanded to include Class B and C waste levels in addition to the Class A waste from the generator cleaning. Further, to ensure that the unit could process other waste streams if needed, waste streams of boric acid and bead and powdered resins were tested. While all testing is not yet completed, the TVR unit has proved that it can process the various waste streams, solidify them in asphalt, and produce an acceptable burial-site end product.

Roddy, J. W.

EVALUATION OF INORGANIC SORBENT TREATMENT FOR LWR COOLANT PROCESS STREAMS
ORNL/TM-8729, Oak Ridge National Laboratory, March 1984.

This report presents results of a survey of the literature and of experience at selected nuclear installations to provide information on the feasibility of replacing organic ion exchangers with inorganic sorbents at light-water-cooled nuclear power plants. The radioactive contents of the various streams in boiling-water reactors and pressurized-water reactors were examined. In addition, the methods and performances of current methods used for controlling water quality at these plants were evaluated. The study also includes a brief review of the physical and chemical properties of selected inorganic sorbents. Some attributes of inorganic sorbents would be useful in processing light-water reactor (LWR) streams. The inorganic resins are highly resistant to damage from ionizing radiation, and their exchange capacities are generally equivalent to those of organic ion exchangers. However, they are more limited in application, and there are problems with physical integrity, especially in acidic solutions. Research is also needed in the areas of selectivity and anion removal before inorganic sorbents can be considered as replacements for the synthetic organic resins presently used in LWRs.

Rodgers, B. R.; Pojasek, R. B.; Schoenberger, R. J.

HAZARDOUS CHEMICAL DEFENSE WASTE MANAGEMENT PROGRAM - TECHNOLOGY REVIEW REPORT: CURRENTLY AVAILABLE TECHNOLOGY
DOE/HWP-4, Oak Ridge National Laboratory, June 1985.

The objectives of this work were to review and to summarize available technological information relevant to the treatment, storage, and disposal (TSD) of DOE - Defense Program (DP) hazardous chemical wastes. The results are presented in a format suitable for use by DOE's Hazardous Waste Program (HWP) and primary DOE contractors. This review emphasizes proven technologies which appear to have potential for immediate impact within the DOE HWP or which could be adapted, through short-term development efforts, to specific DOE needs in TSD. It should thus be used as an initial screening tool in the selection of TSD technologies that could be included in comprehensive waste management strategies developed by DOE and its contractors. Several emerging advanced technologies that may lead to the resolution of existing or future DOE needs were identified during this review of available technology. This work also presents representative information derived from both DOE and private-sector situations regarding waste streams and treatment technologies which are currently applied to, or could appropriately be applied to, these streams. The waste stream classification system developed by the University of California at Davis is used for presentation of this material.

Rose, R. R.; Mahathy, J. M.; Epler, J. S.; et al.

EXPERIENCE AND RELATED RESEARCH AND DEVELOPMENT IN APPLYING CORRECTIVE MEASURES AT THE MAJOR LLW DISPOSAL SITES
ORNL/Sub-82/13810/1, Oak Ridge National Laboratory, July 1983.

A review was conducted of experience in responding to problems encountered in shallow-land burial of LLW and in research and development related to these problems. The operating histories of 11 major disposal facilities were examined. Based on the review, it was apparent that the most effective corrective measures administered were those developed from an understanding of the site conditions that caused the problems. Accordingly, the information in this document has been organized around the major conditions that have caused problems at existing sites. These include: (1) unstable trench cover, (2) permeable trench cover, (3) subsidence, (4) ground water entering trenches, (5) intrusion by deep-rooted plants, (6) intrusion by burrowing animals, and (7) chemical and physical conditions in the trench. Because the burial sites are located in regions that differ in climatologic, geologic, hydrologic, and biologic characteristics, there is variation in the severity of problems among the sites and in the nature of information concerning corrective efforts.

Rose, R. R.; Morrow, C. M.

CORRECTIVE MEASURES HANDBOOK (DRAFT)
Oak Ridge National Laboratory, January 1984.

Based on experience at existing low-level waste burial sites, conditions occur or may develop after burial which can cause problems in waste isolation. These considerations, plus closer scrutiny now given to the operation of burial sites, present the need for assistance in maintaining facilities that are safe.

The purpose of this document is to serve as a handbook to operators of low-level waste burial sites for dealing with conditions which can cause problems in waste isolation. It contains information on planning and applying corrective actions and is organized in such a way as to assist the operator in associating problems, or potential problems, with causative conditions. The operator is thus encouraged to direct his actions at those conditions, rather than the possible temporary expedient of treating symptons. The following conditions that can occur at burial sites are discussed: (1) eroding trench cover, (2) permeable trench cover, (3) subsidence of trench, (4) groundwater entering trenches, (5) trench intrusion by deep-rooted plants, and (6) trench instruction by burrowing animals.

Ross, R.

THE APPLICABILITY OF VARIOUS INCINERATION SYSTEMS TO LOW-LEVEL RADIOACTIVE WASTE
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. D1 to D19, March 1985.

A number of new, and sometimes unique, incinerator concepts have been developed in the last 3 to 5 years which, while virtually unproven on a commercial scale, suggest that the field of incineration technology will be employed to a greater extent in the future. The incineration of low-level radioactive waste has been accomplished in the past by using a variety of incinerator designs, temperatures, materials, and particulate removal systems. To add to the growing list of possibilities, this paper examines several new techniques in detail to assess their possible future use as low-level radioactive waste incineration systems.

The incineration systems that will be analyzed for applicability include the Arc Technologies process, which destroys organic materials in a high-temperature electric-arc furnace; the Penberthy Electromelt System, which uses molten glass to capture the ash; the PEDCO cascading fluid-bed system; and the MODAR sypercritical water system for low concentration of organic-inorganic-aqueous wastes. The aspects of air pollution control and disposal of the ash will also be discussed for each system.

Ross, R. D.

HAZARDOUS WASTE INCINERATION: MORE ATTRACTIVE NOW THAN EVER BEFORE
Hazardous Materials and Waste Management Magazine, pp. 13-19, September-October 1984.

Recent legislation has made incineration an attractive option in waste management. The technologies involved in the incineration of industrial waste include: (1) liquid injection, (2) rotary kiln, (3) fluid bed, (4) multiple-hearth incinerator, (5) starved-air or, as it is called now, controlled-air incinerator.

There are many processes that are new in incineration, but the seven that are listed cover the fairly wide spectrum of the types of systems that may be considered in the future. They include: (1) circulating-bed combustor, (2) molten-salt technology, (3) Penberthy Electro-Melt System, (4) advanced electric reactor, (5) supercritical water, and (6) vertical-tube reactor.

Row, T. H. (Technical Program Chairman)

Transactions of the American Nuclear Society
Vol. 46, June 1984.

Application of Decontamination Technology includes the following article:

1. "Electrolytic Decontamination of Radioactive Metallic Wastes by Alternating Electrolysis in a Neutral-Salt Electrolyte."

LLW Volume Reduction includes the following articles:

1. "Dry Active Waste Composition: The Potential for Volume Reduction,"
2. "Description and Development Status of a Low-Level Combustible Waste Incineration Facility for Volume Reduction at INEL,"
3. "An Economic Analysis of a Fluidized-Bed Volume Reduction System,"
4. "Resin Volume Reduction System,"
5. "Removal of Radioactive Cesium from Streams with a High Potassium Content," and
6. "Waste Experimental Reduction Facility Description and Progress Report."

Row, T. H. (Technical Program Chairman)

Transactions of the American Nuclear Society
Vol. 46, pp. 786-8, June 1984.

Remote Technologoy in Waste Management includes the following articles:

1. "Savannah River Plant Low-Level Waste Incinerator Demonstration," and
2. "Decontamination and Repair Facility for Waste Processing Equipment."

Rummery, T. E.; Rosinger, E. L. J.

THE CANADIAN NUCLEAR FUEL WASTE MANAGEMENT PROGRAM
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 14-32, August 26-29, 1984.

The Canadian Nuclear Fuel Waste Managment Program is in the fourth year of a ten-year generic research and development phase. The objective of this phase of the program is to assess the basic safety and environmental aspects of the concept of isolating immobilized fuel waste by deep underground disposal in plutonic rock.

The major scientific and engineering components of the program, namely immobilization studies, geoscience research, and environmental and safety assessment, are described. Program funding, scheduling, and associated external review processes are briefly outlined.

Rutland, L.; Papaiya, N. C.

ON-SITE STORAGE OF LOW-LEVEL RADWASTE: A SURVEY
EPRI-NP-3617, Electric Power Research Institute, July 1984.

For years, low-level radwaste disposal has been characterized by rapidly increasing disposal costs and reduction in the availability of commercial disposal facility space. Many nuclear utilities have responded to this situation by at least considering augmenting radwaste volume reduction systems and on-site storage facilities. A survey was performed under EPRI sponsorship to contact nuclear power utilities to detail their actions and plans with regard to radwaste volume reduction and on-site storage. This information was analyzed to include the influence of site-specific and regional factors on the utilities' individual responses. This report summarizes the survey findings and presents facility drawings that characterize typical nuclear utility actions and planning. This information should assist nuclear power utilities that will commence similar planning.

Salsman, J. M.

CONSIDERATIONS FOR CREATING A FREESTANDING MONOLITH
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 133-35, March 1985.

The Texas Low-Level Radioactive Waste Disposal Authority is investigating alternatives to shallow-land burial for low-level radioactive waste. This alternative proposes a standard shallow-land burial trench with a reinforced concrete floor over a sand bottom, backfilling the trench voids with concrete instead of sand and using a concrete cap covered with clay and top soil. The use of concrete backfilled trenches in a geologically stale, semiarid area can provide an additional degree of safety, but their use in a geologically unfavorable area could actually create problems. Three reasons for using concrete backfill are: better intruder barriers, creation of a concrete monolith, and lower susceptibility to subsidence. A fourth nontechnical reason is that the public seems to be infatuated with concrete, which may prove to be the best reason for a concrete backfilled trench. The additional cost of using concrete is approximately $\$7.78/ft^3$ of waste buried if the concrete is commerically puchased; however, if a batch plant is utilized, the cost is reduced to $\$1.43/ft^3$.

Saraceno, A. J.; CLick, J. L.; Tracy, J. W.

LABORATORY STUDY OF ELECTRODIALYSIS FOR TREATING COOLING WATER BLOWDOWN
GAT-T-1716, Goodyear Atomic Corporation, May 1971.

A laboratory study of the electrodialysis (ED) process has been conducted to evaluate its application to recirculating water blowdown for water and chemical recovery and for pollution control at the Portsmouth Site. Significant ED process parameters that could markedly reduce costs when current technology is applied to the discharge stream of the plant were stressed. The items examined were: (1) selectivity of electrodialysis toward various anions and cations in RCW; (2) sulfuric acid, caustic, and chlorine recovery; (3) operation at the normally elevated RCW temperatures; (4) operation to minimize polarization effects; and (5) chromate and water recovery. The results show a favorable economic trend for most of these parameters, and the data collected should permit cost estimates of the ED process for specific application to a gaseous diffusion complex.

Saraceno, A. J.; Jones, D. B.; Wiehle, W. E.

PROCEDURE FOR CHROMATE REMOVAL AND RECOVERY BY ION EXCHANGE
GAT-T-1526, Goodyear Atomic Corporation, June 1969.

This report was prepared to account for development work performed at Goodyear Atomic Corporation (GAT) on methods of chromate recovery from recirculating cooling water from 1956 through 1968. Attempts have been made to compare, as completely as possible, significant developments made at GAT with procedures described in U.S. patent 3,223,620, December 14, 1965, Nalco (Appl. July 9, 1963) and U.S. patent 3,306,859, February 28, 1967, Crane (Appl. December 31, 1963). Also included is a description of an advancement in chromate recovery technology which does not appear in patents pertaining to this subject. This advancement is a scheme of upflow exhaustion of chromate from recirculating water (RCW) and downflow regeneration of the ion exchange resin with RCW makeup water. This procedure limits chromate leakage into the RCW effluent to <2 ppm without use of costly regenerating chemicals. Resin life appears to have sufficient longevity to make this method of chromate recovery economically attractive.

Sathrum, C. H.; Stember, D. L.

VOLUME REDUCTION OF DRY ACTIVE WASTE BY A MOBILE SUPERCOMPACTOR SYSTEM
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. G1 to G2, March 1985.

The purpose of this technical paper is twofold: (1) to provide a brief overview of supercompaction as a method for reducing disposed volumes of low-level radioactive waste (LLRW); and (2) to describe one utility's approach to LLRW volume volume reduction at multiple reactor sites by using a newly introduced mobile supercompactor system.

Sauer, R. E.; Jessop, D.

A COMMERCIAL REGIONAL INCINERATOR FACILITY FOR TREATMENT OF LOW-LEVEL RADIOACTIVE WASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 529-37, March 1985.

In 1981, US Ecology, Inc., began studies on the feasibility of constructing and operating a regional radioactive waste incinerator facility. In December 1982, US Ecology requested turnkey quotations from several vendors for engineering, procurement, and construction of the new facility. After technical and commercial evaluations, a contract was awarded to Associated Technologies, Inc., of Charlotte, North Carolina, in June 1983. In June 1984, US Ecology made a public announcement that they were studying two sites in North Carolina for location of the facility. This same month, they submitted their permit application for a radioactive material license to the North Carolina Department of Human Resources. The facility will accept wastes from power reactors, medical and research institutions, and other industrial users and will incinerate dry solid waste, pathological waste, scintillation fluids, and turbine oils. The incinerator will be a dual chamber — controlled air design, rated at 600 lb/h (273 kg/h), with a venturi scrubber, packed column, HEPA filters, and charcoal filters for pollution control.

Schaich, R. W.

OAK RIDGE NATIONAL LABORATORY SHIPPING CONTAINERS FOR RADIOACTIVE MATERIALS
ORNL/TM-7179/R1, Oak Ridge National Laboratory, September 1984.

The packages are divided into the following categories:

A. ORNL Type A Packages
   1. DOT-IAEA Type A ORNL Shipping Containers
      a. Radioactive Liquids and Solids
      b. Radioactive Solids Only
      c. Radioactive Gases

B. ORNL Type B Packages
   1. Radioactive Gases
   2. Radioactive Solids

C. Commercial Packages Shipped from ORNL

D. ORNL Special Form Containers

Schmieder, H; Huppert, K. L.

OPERATING EXPERIENCE AND TECHNIQUES FOR MINIMIZING WASTES
ORNL-tr-4391, Society of German Chemists, March 1977.

This article claims denitrification directly to N_2, avoiding NO_x.

The main product at the graphite cathode is nitrogen, along with small amounts of hydrogen. Only at low acid concentrations is there evolution of NO.

Schmitt, R. C.; Chapman, R. L.; Sumpter, K. C.; Reno, H. W.

HIGH-INTEGRITY CONTAINERS: A DEMONSTRATED DISPOSAL ALTERNATIVE TO SOLIDIFICATION OF RADIOACTIVE WASTES
EGG-M-19883, EG&G Idaho, Inc., March 11-15, 1984.

The EPICOR and Waste Research and Disposition Program at the Idaho National Engineering Laboratory developed, tested, and is using a High-Integrity Container (HIC) for commercial disposal of EPICOR-II pre-filter liners from the cleanup of Unit 2 of the Three Mile Island Nuclear Power Station. The HIC permits disposal of EPICOR-II liners as Class "C" low-level radioactive wastes without prior solidification of resins therein. Design rationale for and testing of the HIC is discussed, and costs of using the container for disposal of EPICOR-II liners are compared with those of solidificaton. It is concluded that the HIC is a cost-competitive alternative to solidification for disposal of unusual types and quantities of low-level radioactive wastes.

Schmitt, R. C.; Reno, H. W.

EXPERIENCES IN DEVELOPMENT, QUALIFICATION, AND USE OF CONCRETE HIGH-INTEGRITY CONTAINERS IN COMMERCIAL DISPOSAL OF RADWASTE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 299-301, March 1985.

Disposal of EPICOR prefilters as commercial radioactive waste is being accomplished by using a first-of-a-kind, reinforced concrete, high-integrity container in lieu of prior in situ solidification of resins before disposal of prefilters. Experiences in developing, testing, certifying, and using high-integrity containers are an untold story worthy of review for the benefit of the nuclear industry at large. The lessons learned in gaining regulatory acceptance of the concrete HIC are discussed in this paper.

Scholz, R.; Milanowski, J.

MOBILE SYSTEM FOR EXTRACTING SPILLED HAZARDOUS MATERIALS FROM SOILS
Resnord, Inc., Environmental Protection Agency, December 1983.

Laboratory tests were carried out with three different pollutants [phenol, arsenic trioxide, and polychlorinated biphenyls (PCBs)] and two soils of different character to evaluate a technique for the scrubbing or cleansing of soils contaminated with hazardous materials. The results of these tests were used to design a full-scale prototype system for field evaluation in cleaning contaminated soils. The system employs two major soil scrubbing components: a newly designed water knife stripper for breaking up soil lumps and stripping chemicals from larger particles (>2 mm in diameter), and a countercurrent chemical extractor for washing smaller particles. During limited laboratory extraction tests, phenol was very efficiently removed from both organic and inorganic soils, whereas PCB and arsenic clung tightly to the soils and released far less in the washing fluids. Chemical testing is inconclusive until acceptable limits of residual concentrations in the washed soil are adopted. Laboratory tests showed that soil scrubbing can vastly speed up the release of chemicals from soils, a process that occurs very slowly under natural leaching conditions. A protype soil scrubbing has been constructed.

Schultz, D.; Salasin, J.; Sassaman, J.; Smith, W.

RISK ASSESSMENT FOR A CONTAMINATED SITE IN MISSION, TEXAS
MTR-81W284, MITRE Corporation, April 1982.

The Dusek property in Mission, Texas, has been contaminated with pesticides and pesticide metabolites. MITRE has undertaken two tasks to determine the hazard posed to the adjacent population by the contamination of the Dusek property. First, the risk of additional cancers in nearby residents due to long-term exposure to current concentrations of chlordane, lindane (as beta-BHC), toxaphene, and DDT was estimated. Second, the risk that would result from four cleanup proposals was determined. The estimated risk of cancer ranged from 4×10^{-6} to 3.5×10^{-4}, depending on the geographical location at which risk was estimated.

Schultz, D.; Salasin, J.; McLaughlin, M.; Smith, W.; Spring, J.

RISK ASSESSMENT FOR A CONTAMINATED SITE IN ST. LOUIS, MICHIGAN
MTR-81W286, MITRE Corporation, April 1982.

The Velsicol Chemical Corporation site in St. Louis, Michigan, has become contaminated with a number of hazardous substances, including DDT, polybrominated biphenyls, hexabromobenzene, and tris(2,3-dibromopropyl) phosphate. The risk of additional cancers in residents in the vicinity of the plant site has been estimated for exposure to the chemicals via inhalation, ingestion, and dermal absorption. The summed risk from exposure to the four chemicals via inhalation of chemical vapor and contaminated dust is of the order of 10^{-4} to 10^{-5}. The summed risk associated with ingestion of contaminated soil is of the order of 10^{-3} due almost entirely to the risk estimated for DDT. The risk estimated for ingestion is probably considerably higher than will actually be experienced for reasons given in the report. The summed risk associated with dermal absorption is of the order of 10^{-5}, an estimate that is also considered high.

Shuckrow, A. J.; Dawson, G. W.; Bonner, W. F.

PHYSICALCHEMICAL TREATMENT OF COMBINED AND MUNICIPAL SEWAGE
EPA-R2-73-149, Environmental Protection Agency, February 1973.

In the wastewater treatment process, raw wastewater is contacted with powdered carbon, coagulated with alum, settled with polyelectrolyte addition, and, in some cases, passed through a trimedia filter. The solids from the clarifier, composed of raw sewage solids, powdered carbon, and aluminum hyroxide floc, are readily dewaterable to 20-25% solids by direct centrifugation, with the powdered carbon acting as a substantial aid to dewatering. The dewatered solids are passed through a fluidized-bed furnace developed specifically for powdered carbon regeneration. Alum is recovered by acidifying the regenerated carbon slurry from the furnace to a pH of 2. The recovered carbon and alum are recycled as an acidified slurry and added to the raw sewage with the makeup carbon. The program demonstrates the ability of the treatment process to consistently produce high-quality effluent from raw wastewater. Powdered-carbon regeneration was highly successful on the pilot scale. Full-capacity recovery was achieved with less than <2% carbon loss per regeneration cycle. Alum recovery was also >90%.

Shultz, C. G.

APPLICATION FOR PERMIT FOR RESEARCH AND DEVELOPMENT ON DESTRUCTION OF PCBs AND OTHER ORGANIC HAZARDOUS WASTES - ALTERNATE METHOD: THERMAL REDUCTION . . .
National Laboratories, Inc., 1984.

The process involves spraying PCB into a reactor where it is exposed to the surface of molten aluminum. The aluminum acts as a strong reducing agent, removing the chlorine atoms from the molecule, and forming the more stable aluminum chloride. Carbon and low-molecular-weight organic gases are also formed. The aluminum chloride formed is a gas at the reaction temperature and will pass through the reactor with the other gases. Some carbon will be entrained in the gas stream and will be trapped in the gas cleanup system.

The article also describes other organic hazardous wastes that will react with aluminum to form different nonhazardous products.

Shultz, C. G.

DEMONSTRATION OF THE DESTRUCTION OF POLYCHLORINATED BIPHENYLS (PCBs) USING MOLTEN ALUMINUM - APPENDIX A
National Laboratories, Inc., June 1984.

Data have been obtained on the destruction of PCBs in support of a patent application (Ser. No. 346636). In none of the prior experiments have the conditions been optimum. Efforts are continuing to obtain a suitable configuration of equipment to make the process more economical, efficient, and cost-effective. This report encompasses one such experiment.

Although the experiment reported here was not free of all of these problems, it was sufficiently sustained that meaningful data could be obtained. The process involving the contact of halogenated organic compounds with molten aluminum is very effective in removing the chlorine and destroying the organic compound.

Shultz, C. G.

DEMONSTRATION OF THE DESTRUCTION OF MALATHION AND PARATHION AS SURROGATES FOR NERVE GASES
National Laboratories, Inc., December 1984.

Since the issue of U.S Patent 4,469,661 relating to destruction of PCBs with molten aluminum, applications have been filed covering the destruction of other organic hazardous wastes, inorganic oxidants, nerve gases, and other cholinesterase inhibitors. This report covers the demonstration of the destruction of Malathion for engineers from GA. Technologies, Inc., who are contractors to the U.S. Army under the Chemical Demilitarization Program. It also includes a later experiment in which Parathion was destroyed using the same process and equipment.

These experiments demonstrated the effectiveness of molten aluminum in destroying organic compounds containing chlorine, phosphorus, and sulfur.

Sims, R. C.; Sims, J. L.; Sorensen, D. L.; McLean, R.; et al.

REVIEW OF IN-PLACE TREATMENT TECHNIQUES FOR CONTAMINATED SURFACE SOILS - VOLUME 1: TECHNICAL EVALUATION
EPA-540/S2-84-003, Hazardous Waste Engineering Research Laboratory, September 1984.

This two-volume report presents information on in-place treatment technologies applicable to contaminated soils at shallow depths. Volume 1 discusses the selection of the appropriate in-place treatment technology for a particular site and provides specific information on each technology. Volume 2 provides background information and relevant chemical data. Selection of in-place treatment technologies follows the process outlined in the National Contingency Plan. The type of in-place treatment (extraction, immobilization, degradation, attenuation, or reduction of volatiles) is determined on the basis of information available from the remedial investigation. Selection of a specific technology involves the assessment of waste, soil, and site-specific variables. The technology is implemented if it is considered more cost-effective in comparison with the alternatives. Volume 1 provides a guide for selection of in-place treatment technologies, a discussion of each in-place treatment technology, data for estimating the costs of implementing in-place treatment, and an appendix on cost information.

Siskind, B.; Dougherty, D. R.; MacKenzie, D. R.

EXTENDED STORAGE OF LOW-LEVEL RADIOACTIVE WASTE: POTENTIAL PROBLEM AREAS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 51-56, March 1985.

If a state or state compact does not have adequate disposal capacity for low-level radioactive waste (LLRW) by 1986 as required by the Low-Level Waste Policy Act, then extended storage of certain LLRW may be necessary. In this paper, the issue of extended storage of LLRW is addressed in order to determine for the NRC the areas of concern and the actions recommended to resolve these concerns. The focus is on the properties and behavior of the waste form and waste container. Storage alternatives are considered in order to characterize the likely storage environments for these wastes. The areas of concern about extended storage of LLRW are grouped into two categories:

1. behavior of the waste form and/or container during storage (e.g., radiolytic gas generation, radiation-enhanced degradation of polymeric materials, and corrosion); and
2. effects of extended storage on the properties of the waste form and/or container material that are important after storage (e.g., radiation-induced oxidative embrittlement of high-density polyethylene and the weakening of steel containers resulting from corrosion by the waste).

Sittig, M. (Editor)

PRIORITY TOXIC POLLUTANTS - HEALTH IMPACTS AND ALLOWABLE LIMITS
Noyes Data Corporation, 1980.

A new era is at hand in industrial pollution control. Whereas the efforts of the U.S. Environmental Protection Agency in the past have been directed to the control of so-called conventional pollutants in the nation's water supply, a new set of guidelines has now been mandated.

Based on a consent decree obtained in federal court by public interest groups, the EPA has been directed to establish standards for a list of 65 "priority" toxic pollutants (actually reflecting 129 individual compounds) to regulate discharges of such materials to the nation's waterways for the protection of both aquatic and human life.

The priority toxic pollutants are also of concern to those involved in air pollution control and solid waste disposal. This volume is intended to provide in ready reference form the essentials of the criteria that have been proposed (1)-(65) for the control of priority toxic pollutants.

Slope Indicator Company (SINCO)

GEOTECHNICAL, GEOPHYSICAL, GROUNDWATER, AND STRUCTURAL INSTRUMENTATION
Promotional Brochure, Slope Indicator Company, June 1984.

The Slope Indicator Company (SINCO), founded in 1958 to manufacture the original Slope Indicator inclinometer, now markets a full line of geotechnical, geophysical, structural, and groundwater instrumentation. These instruments measure and record horizontal and vertical movements in soil and rock, water and earth pressures, in situ moduli of rock, structural strains, ground vibrations, and acoustic emissions from soil and rock. Terrametrics, a division of the Slope Indicator Company, specializes in rock mechanics instruments. With the acquisition of Terrametrics in 1983, SINCO expanded its line of instrumentation systems for measuring in situ behavior of rock, soil, and concrete. In addition, detailed installation instructions, monitoring procedures, and field services can be provided as needed. SINCO maintains a complete in-house manufacturing facility that includes design, prototype development, construction, and testing for electrical, mechanical, hydraulic, and pneumatic instruments.

Smith, G. J.

IMPLEMENTATION PLAN FOR HAZARDOUS AND RADIOACTIVE MIXED WASTE MANAGEMENT AT SANDIA NATIONAL LABORATORIES ALBUQUERQUE
Sandia National Laboratories, Albuquerque, New Mexico, January 1984.

Sandia National Laboratories Albuquerque (SNLA) is a multidisciplinary laboratory engaged in the research and development of weapons and alternative energy sources. SNLA is managed by Western Electric Company for the Department of Energy, with substantial work performed for the Department of Defense and the Nuclear Regulatory Commission. The laboratories fall under the SIC code number 9711, national defense organizations.

Included in this report are: (1) a list of waste generation sources; (2) waste handling operations; (3) site description; (4) list of hazardous waste storage, treatment, and disposal facilities; (5) records, both day-to-day and general facility; and (6) cost estimate summaries.

Also included are: Appendix A - Waste Sampling and Analysis Plan for Hazardous Waste at SNLA; Appendix B - Copy of Permit issued to SNLA; and Appendix C - Listing of Materials Handled at SNLA.

Smith, K. R.

DEVELOPMENT OF A MOBILE VOLUME REDUCTION SYSTEM
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. M1 to M5, March 1985.

In June 1983, Aerojet Energy Conversion Company (AECC) initiated an internal program to develop a mobile volume reduction system (MVRS) capable of processing the low-level dry, active wastes (DAW) and contaminated oils produced at nuclear power stations. Development objectives included the utilization of existing incineration technology, the application of AECC-developed liquid off-gas cleanup technology, the ability to operate independently of utility-supplied builidngs, the ability to economically process and dispose of the ash produced during the combustion process, and the capability for operating and maintaining the MVRS in an ALARA manner.

Smith, K. R.

MOBILE INCINERATION SERVICES AT COMMONWEALTH EDISON'S NUCLEAR STATIONS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 511-12, March 1985.

As the costs for low-level waste disposal escalate and as January 1, 1986, draws nearer, utilities throughout the United States are formulating and implementing plans to reduce the volumes of low-level radioactive waste being generated at their nuclear power stations. Techniques being used to accomplish this goal range from sorting of dry active waste to complete volume reduction systems, such as the Aerojet VR Systems being installed at Commonwealth Edison's Byron and Braidwood Stations. In between these extremes are partial solutions to the problem, including compaction, shredding and compaction, supercompaction, resin dewatering, liquid drying, and mobile incineration. This paper is intended to summarize some of the key elements resulting from the design, fabrication, and testing of the mobile volume reduction system (MVRS) supplied by Aerojet Energy Conversion Company for Commonwealth Edison Company of Chicago, Illinois. In addition, it is intended to identify those tasks which a potential user of the MVRS service must complete in order to receive permission from the NRC to operate the MVRS at their site.

Smith, W. S.; Carrara, G. J.

EMISSIONS TESTING PLAYS PIVOTAL ROLE IN PERFORMANCE EVALUATION FOR INCINERATION STANDARDS
Hazardous Materials and Waste Management Magazine, pp. 22-26, September-October 1984.

In the "Hazardous Waste Control and Enforcement Act of 1983" (H.R. 2867), Congress is seeking more definitve action by the EPA toward hazardous waste incineration. The advantages of incinerating hazardous wastes are several: toxic components can be converted to harmless compounds; volume can be greatly reduced; heat recovery is possible as a means of saving energy; and incineration provides ultimate disposal, thereby eliminating the possibility that waste-related problems might surface at a later date. Because of these advantages and the fact that even low-heating-value waste can be burned when accompanied with auxiliary fuels, incineration may become a principal technology for hazardous waste disposal in the near future. Granting of a RCRA permit to operate a hazardous waste incinerator is contingent upon a preliminary demonstration that the system and operating procedures proposed will achieve a destruction and removal efficiency (DRE) of 99.99%. Presently, two sampling systems - the VOST (Volatile Organic Sampling Train) and MM5 Train (Modified Method 5 Train) - have been found to achieve the desired sensitivity to determine the DRE values for a variety of compounds.

Societe Generale Pour Les Techniques Nouvelles - SGN

RADWASTE INCINERATION SYSTEM
Societe Generale Pour Les Techniques Nouvelles, November 1984.

The CEA Group has developed a radwaste incineration system which includes preliminary sorting of wastes, gas treatment, and conditioning of ashes. The ash-conditioning system is compatible with other residues and can be adapted to meet the specific requirements of each project.

The incinerator comprises a two-combustion chamber system:

1. The first is equipped with special, patented grates particularly adapted to plastics and rubber.
2. The second, the post-combustion chamber, is filled with patented refractory material which is highly efficient in the destruction of unburnt solid or gaseous residues.

Soden, J. E.; Johnson, J. C.

BURIAL AND OTHER HIGH-POTENTIAL RESPONSE TECHNIQUES FOR SPILLS OF HAZARDOUS CHEMICALS THAT SINK
JBF Scientific Corporation, pp. 202-7, circa 1976.

The U.S. Coast Guard sponsored a study by the U.S. Army Engineer Waterways Experiment Station (WES) on response techniques for a list of 70 hazardous chemicals that sink in water. The detailed investigation of dredging and the synthesis of technical information were performed by WES. JBF Scientific Corporation investigated burial and other high-potential response techniques and provided detailed technical reports to WES.

The results of the feasibilty study of burial and other high-potential response techniques applicable to a list of 70 hazardous chemicals that will sink if spilled into water are reported in this paper. The feasibility study consisted of a literature review and technical evaluation. Original laboratory and field work were beyond the scope of this study.

The authors of this paper concentrate on the containment and treatment phases of spill response. Removal of spilled material by dredging is not discussed.

Soto, R.; Harkins, R.

MOBILE LIQUID VR SYSTEM - A COST-EFFECTIVE ALTERNATIVE
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 191-5, March 1985.

As part of a continuing effort to introduce cost-effective alternatives for treating large volumes of liquid radwaste, HPD, Inc., and Chem-Nuclear Systems, Inc., have integrated two proven state-of-the-art technologies to offer a mobile liquid volume reduction system that satisfies the requirements of the nuclear industry with respect to liquid radwaste handling. This system optimizes proven technology by employing a crystallizer unit to concentrate the waste liquids to 50 wt % solids, thereby reducing the volume to be solidified by factors of 40 while using only 20% of the energy required by conventional evaporative systems. In addition, the system employs a field-proven cement solidification process which has been accepted in a topical report by the USNRC and offers the highest waste-to-container volume ratios for stable waste forms in the industry. This volume reduction — solidification system is able to reduce over 7000 gal (26,500 L) of liquid waste per day to less than 30 ft^3 (0.85 m^3) of 10 CFR 61 certified stable solidified waste for ultimate disposal or on-site storage. This document describes the GEODEsm System — its applicability, economics, volume reduction, scope of responsibility, and experience.

South Carolina Department of Health and Environmental Control

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
RADIOACTIVE MATERIAL LICENSE
License No. 097, Amendment No. 41, South Carolina Department of Health and Environmental Control.

This document is a radioactive material license issued by the state of South Carolina to Chem-Nuclear Systems, Inc., Barnwell Waste Management Facility, P.O. Box 726, Barnwell, SC 29812.

The license specifies the amount of waste that can be possessed at any one time and how the waste should be packaged. Other conditions and specifications are also stipulated.

This license expires December 31, 1992.

Southwest Research Institute/EPA

DISPOSAL OF HAZARDOUS WASTE
EPA-600/9-80-010, Southwest Research Institute, Environmental Protection Agency, March 1980.

The Sixth Solid and Hazardous Waste Research Divison Research Symposium on Treatment of Hazardous Waste was held at the Conrad Hilton Hotel in Chicago, March 17-20, 1980. The purpose of the symposium was twofold: (1) to provide a forum for a state-of-the-art review and discussion of ongoing and recently completed research projects dealing with the management of hazardous wastes, and (2) to bring together people concerned with the disposal of hazardous waste who can benefit from an exchange of ideas and information. In this document, the "Disposal" volume, the following seven technical areas are covered:

1. waste sampling and characterization - 5 papers,
2. transport and fate of pollutants - 4 papers,
3. pollutant control - 6 papers,
4. codisposal - 3 papers,
5. landfill alternatives - 2 papers,
6. remedial actions - 1 paper, and
7. thermal destruction techniques - 1 paper.

Southwest Research Institute/EPA

TREATMENT OF HAZARDOUS WASTE
EPA-600/9-80-011, Southwest Research Institute, Environmental Protection Agency, March 1980.

The Sixth Solid and Hazardous Waste Research Division Research Symposium on Treatment and Disposal of Hazardous Waste was held at the Conrad Hilton Hotel in Chicago, during March 17-20, 1980. The purpose of the symposium was twofold: (1) to provide a forum for a state-of-the-art review and discussion of ongoing and recently completed research projects dealing with the management of hazardous wastes, and (2) to bring together people concerned with hazardous waste management who can benefit from an exchange of ideas and information.

In this document, the "Treatment" volume, the following five technical areas are covered:

1. waste sampling and characterization - 2 papers,
2. waste treatment and control - 5 papers,
3. pesticide treatment and control - 4 papers,
4. thermal destruction techniques - 2 papers, and
5. economics - 3 papers.

Sprau, D. D.; Lao, Y. J.; Gaiser, J.

INCINERATION OF LOW-LEVEL RADIOACTIVE WASTE--UP THE STACK WITHOUT A MONITOR!

Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. S1 to S2, March 1985.

For the past 2 years, we have been monitoring the incinerator used by the East Carolina University School of Medicine for low-level radioactive waste disposal. Our monitoring program has consisted of (1) periodic air sampling in the incinerator stack; (2) sampling ash to determine radionuclide content; (3) contamination surveys around the incinerator; and (4) determining activity and radionuclides within the incinerator. Results of our monitoring have convinced us that low-level radioactive waste incineration remains, for the most part, an attractive disposal alternative. There are, however, some substantial problems in monitoring and knowing the activities of ^{14}C and tritium released in the stack effluent. These problems are the lack of on-line monitors for long waste burns and the time required for accurate laboratory analyses. The waste picked up in laboratories is often mislabeled with regard to activity. Activities are usually overestimated, but underestimations do occur. This problem, along with its effect on the future of low-level radioactive waste incineration, is discussed.

Staehr, J. P.

A NEW APPROACH FOR EFFECTIVE SOLIDIFICATION OF LLR WASTE

Nuclear Plant Safety, pp. 12-14, July-August 1984.

The immobilization of low-level radioactive wastes with cement has long been an attractive method since it is readily available and reasonably inexpensive. Conventional techniques, however, do not ensure waste product integrity and efficient volume utilization. An innovative chemical and process research program undertaken by Chem-Nuclear Systems, Inc., has resulted in improved formulations, repeatable test parameters, and a final product that meets or exceeds all the criteria established in the U.S. Nuclear Regulatory Commission (NRC) Waste Form Branch Technical Position (BTP). The following conclusions have been made about the new product:

1. it surpasses the NRC Branch Technical Position requirement;
2. resin bead swelling has been eliminated;
3. BWR and resin formulas gain strength after submergence in water; and
4. All solidified waste forms far surpass the 50-psig requirement for compressive strength.

Stewart, T. L.; Hartley, J. N.

EVALUATION OF IMPROVED CHEMICAL WASTE DISPOSAL AND RECOVERY METHODS FOR N-REACTOR FUEL FABRICATION OPERATIONS: 1984
PNL-5294, Pacific Northwest Laboratory, December 1984.

Pacific Northwest Laboratory personnel identified and evaluated alternative methods for recovery, recycle, and disposal of waste acids produced during N-Reactor fuel operations. This work was conducted under a program sponsored by UNC Nuclear Industries, Inc.; the program goals were to reduce the volume of liquid waste by rejuvenating and recycling acid solutions and to generate a residual waste that is low in nitrates, fluorides, and metals. Disposal methods under consideration included nitric acid reclamation, grout encapsulation of final residual waste, nitrogen fertilizer production, biodenitrifaction, chemical or thermal destruction of NO_3, and short-term impoundment of liquid NO_3^-/SO_4^{2-} wastes. Preliminary testing indicated that the most feasible and practicable of these alternatives were (1) nitric acid reclamation followed by grouting of residual waste, and (2) nitrogen fertilizer production.

This report summarizes the investigations, findings, and recommendations for fiscal year 1984.

Stockinger, S. L.; Rossmassler, R. L.

THE CASE FOR INCINERATING AND SUPERCOMPACTING DRY ACTIVE WASTE AT THE STATE OR REGIONAL LEVEL
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. I1 to I11, March 1985.

The "Low-Level Radioactive Waste Policy Act" placed the responsibility for ensuring adequate disposal capacity on each of the states. As an additional incentive, states and regional Compacts may restrict disposal to wastes generated within the region after January 1, 1986. The possibility of having no sites to which waste can be shipped is very high for many states. Many economic analyses have been performed by large generators of waste to justify volume reduction technology. It is time for states and regions to evaluate economic alternatives and to provide a total waste management plan for all generators. The data available are sufficient for many states and/or regions to justify volume reduction facilities. These facilities could contain an incinerator and/or a supercompactor. In addition to the basic economics, the volume reduction of dry, active waste (DAW), once disposed in a shallow-land burial site, will improve site stability and reduce long-term site maintenance. This paper examines the economics of such a facility and concludes that the economic viability exists and should be implemented.

Stone, J. A.; Fenimore, J. A., et al.

SHALLOW-LAND BURIAL OF SOLID LOW-LEVEL RADIOACTIVE WASTES - 30 YEARS OF EXPERIENCE AT SAVANNAH RIVER PLANT
IEA-CN-43/270, E. I. du Pont de Nemours & Company, circa 1983.

Solid radioactive wastes from the production of nuclear materials at the Savannah River Plant (SRP) are buried in shallow trenches on a 79-ha plot within the SRP site. The SRP burial ground, in use since 1953, has provided containment for about 370,000 m^3 of waste containing 10^7 Ci that has been buried up to 1982. Site characteristics, operating practices, and monitoring results are described in this paper. Extensive field and laboratory studies aimed at developing a fundamental understanding of the soil/waste system of the SRP burial ground are discussed. Leaching and migration of buried radionuclides have been monitored by assays of soil cores and by periodic sampling of numerous groundwater wells. Except for tritium, none of the radionuclides have migrated significantly from the waste. Generally, traces of alpha and nonvolatile beta/gamma emitters that have entered the groundwater can be detected only by ultra-low-level radiochemical analyses. Ongoing waste migration studies are being performed to ensure continued safe operation and to provide technical guidance for site operations and decommissioning.

Stretz, L. A.; Bourduin, L. C.; Draper, W. E.; et al.

CONTROLLED AIR INCINERATION OF HAZARDOUS CHEMICAL WASTE AT THE LOS ALAMOS NATIONAL LABORATORY
Los Alamos National Laboratory, circa 1980.

An incineration system, originally demonstrated as a transuranic (TRU) waste volume-reduction process, is described. The production-scale controlled air incinerator using commercially available equipment and technology was modified for solid radioactive waste service. The same incinerator and off-gas treatment system have been modified further for use in evaluating the destruction of hazardous liquid wastes such as polychlorinated biphenyls and hazardous solid wastes such as pentachlorophenol (PCP)-treated wood.

Results of a PCP-treated wood incineration test show a PCP destruction efficiency of greater than 99.99% in the primary chamber for the operating conditions investigated. Conditions and results for this test are described.

Stull, E. A.; Merry-Libby, P.

COMPARISON OF LAND AND OCEAN DISPOSAL ALTERNATIVES FOR BULK WASTES CONTAINING NATURALLY OCCURRING RADIONUCLIDES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 137-40, March 1985.

Land and ocean disposal alternatives for a large volume of wastes and residues containing naturally occurring radionuclides are assessed. These wastes and residues are currently stored at the U.S. Department of Energy's Niagara Falls Storage Site near Lewiston, New York. Both land and ocean disposal are considered for the 180,000 m^3 of slightly contaminated wastes (average, 36 pCi/g ^{226}Ra), whereas only land disposal is considered for the 11,000 m^3 of residues (average, 67,000 pCi/g ^{226}Ra). The land and ocean disposal alternatives share similar engineering considerations, occupational and transportation risks, and radiological risks. Impacts from placement of the wastes in the ocean would be negligible. However, the land-based activities required to transport the wastes to the ocean would account for most of the potential impacts associated with the ocean disposal alternatives. Thus, the land and ocean disposal alternatives are comparable in terms of potential environmental impacts.

Sturchio, G. M.

IMPLEMENTATION AND ASSESSMENT OF A BIOLOGICAL RADIOACTIVE WASTE INCINERATION PROGRAM
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. T1, March 1985.

The use of incineration to handle the disposal of biological low-level radioactive waste at the University of California at Davis is examined. A unique compromise agreement between the Sewage Treatment Plant staff and the Health Physics group has been established for use of the campus pathological incinerator, as well as administrative and technical protocols to ensure compliance with state radiation control regulations.

The development of criteria to limit the quantity of an isotope incinerated and to mitigate the need for stack monitoring will be discussed. Additionally, an assessment of the program will show significant savings, concomitant with a reduction in radioactive waste volume.

Swennen, R.; Cuyvers, H.; Van Gel, J.

THE TREATMENT OF COMBUSTIBLE ALPHA WASTES AT EUROCHEMIC USING ACID DIGESTION AND A PLUTONIUM RECOVERY PROCESS. Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 549-59, August 26-29, 1984.

At Eurochemic, 800 kg of combustible alpha wastes, containing 7±1 kg of plutonium, is being treated using acid digestion and a process to recover the plutonium from the acid digestion residues. The wastes are first soaked in cold sulfuric acid, and the resulting slurry is fed into a ring-type acid digester which is kept at 250°C. In the process, the plutonium is converted into the sulfate. It is brought into solution by a leaching procedure, separated by extraction using a primary amine, and finally converted into the dioxide by an oxalate precipitation and by calcination. A material balance shows that 93% of the 2.2 kg of plutonium fed into the digester is recovered in the form of the dioxide.

Tallman, J. A.

SAVANNAH RIVER PLANT LOW-LEVEL WASTE INCINERATION DEMONSTRATION P-MS--84-7, E. I. du Pont de Nemours & Company, 1984.

A 2-year demonstration facility was constructed at the Savannah River Plant (SRP) to incinerate suspect contaminated solid and low-level solvent wastes. Since startup in January 1984, 4460 kg and 5300 L of simulated (uncontaminated) solid and solvent wastes have been incinerated to establish the technical and operating data base for the facility. Combustion safeguards have been enhanced, process controls and interlocks refined, some materials handling problems identified, and operating experience gained as a result of the month-long cold run. Volume reductions of 20:1 for solid and 25:1 for solvent wastes have been demonstrated.

Stack emissions (NO_2, SO_2, CO, and particulates) were only 0.5% of the South Carolina ambient air quality standards.

Tanzman, E.; LaBrie, B.; Lerner, K.

OVERVIEW OF HAZARDOUS WASTE REGULATION AT FEDERAL FACILITIES
ANL/EES-TM-182, Argonne National Laboratory, May 1982.

This report provides an overview of the Resource Conservation and Recovery Act (RCRA) of 1976 and its regulation of federal facilities. It is organized in a fashion that is intended to explain the legal duties imposed on offices responsible for hazardous waste at each stage of its existence. Section 2 describes federal hazardous waste laws, and the penalties for violation of the standards are summarized. Although the focus of Section 2 is on the RCRA, other federal statutes are discussed as appropriate. Section 3 covers state regulation of hazardous waste.

Tennessee Valley Authority

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT
Design Study S027, Tennessee Valley Authority, January 1984.

Recent changes in the burial-ground pricing structure, advances in radwaste technology, and the enactment of the Low-Level Waste Policy Act have caused TVA to reevaluate (1) the need for on-site storage and (2) the extent of volume reduction (VR) for wastes generated at its nuclear plant sites. EN DES, a computer code developed by EPRI, has been used to perform a comprehensive cost-benefit study to evaluate potential alternatives available to TVA. Based on Power's current perception that the near-term risk of reduced availability of waste disposal sites is minimal, a new radwaste management plan is recommended. The recommended approach includes substantial volume reduction, involves minimal capital expenditures, and has a positive cost benefit. The recommendation encompasses liquid radwaste treatment system improvements, dry active waste compaction improvements, and volume-reducing solidification systems at all plants. The total amount of capital expenditure ranges from $13.8 million to $27.3 million (depending on whether solidification equipment is leased or purchased). The projected net operating cost savings is $137 million. The overall waste volume is reduced from 194,000 ft^3 (5200 m^3) to 94,000 ft^3 (2500 m^3) per year.

Terrametrics, Inc.

GLOTZL MEASUREMENT SYSTEMS
Promotional Brochure, Terrametrics, Inc., August 1979.

This brochure describes the Glotzl measuring apparatuses. Since 1964, Terrametrics has represented Glotzl Gesellschaft fur Baumesstechnik mbH in the United States and other selected countries. Terrametrics has provided assistance in the definition and planning of programs utilizing Glotzl devices, on-site customer training, and consultation on evaluation and application of the resulting data. All Glotzl cells utilize a unique by-pass valve assembly, a feature that permits the isolation of the sensing system of the various cells from the measuring (readout) medium. Separating sensing and readout circuitry is a distinct advantage since it allows control of characteristics of the sensing components to provide maximum response in diverse material types and applications. Types of cells described in the brochure are (1) earth pressure cells; (2) concrete stress cells; (3) pore water pressure cells; (4) load cells; and (5) special cells such as settlement cells, push-in earth pressure cells, very small cells, and concrete form cells.

Terrell, M. S.

SOLVING SAMPLING PROBLEMS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 437-39, March 1985.

The implementation of 10 CFR 61 and the adoption of the International Atomic Energy Agency's "Regulation for the Transport of Radioactive Materials" by the DOT requires that extensive analysis be performed on the waste products that are generated by facilities which produce or utilize by-product materials. Specifically, the waste products must be analyzed to determine the presence and concentration of by-product materials. Representative samples of the waste products are necessary to perform this analysis. Most waste streams are sampled with some difficulty; however, obtaining representative samples from volume reduced waste product streams is even more difficult. Mathematical correlation models can be used to analyze these waste products, but representative sampling is still needed periodically to verify the correlations. The purpose of this paper is to share how Duke Power Company has solved the problems we have encountered in obtaining representative samples from items such as cartridge filters, resin slurries, and volume reduced dry product.

Thompson, M. L.; et al.

AZTECH SYSTEMS AND TESTING
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 233-37, March 1985.

The General Electric Company, Nuclear Energy Business Operations, has developed an advanced technology radwaste system known as the AZTECH volume reduction and solidification system. This system will be used for the treatment of low-level waste streams typically encountered in BWR and PWR plants. This paper discusses the systems and approach used for development of the AZTECH process, as well as waste from qualification testing performed by General Electric to satisfy the 10 CFR 61 licensing requirements. The AZTECH process development equipment included bench-scale, pilot-plant, and full-scale demonstration systems. The qualification testing program follows the specific 10 CFR 61 requirements guidance, including test standards, provided in the NRC Branch Technical Position on waste form.

Toste, A. P.; Kirby, L. J.; Pahl, T. R.; Myers, R. B.

MAPPING SUBSURFACE RADIONUCLIDE MIGRATION AND GROUNDWATER FLOW WITH ORGANIC TRACERS
PNL-SA--LL388, Pacific Northwest Laboratory, October 1983.

PNL constructed an experimental study area adjacent to one of the waste-filled trenches at the Maxey Flats, Kentucky, site. This report describes some of the preliminary results of organic research currently under way. This research is aimed at (1) elucidating the role of organic species in the subsurface migration of radionuclides, and (2) testing the usefulness of "artificial" and "in situ" organic groundwater tracers for mapping radionuclide migration and groundwater flow. We also describe two analytical procedures developed for the research. First, as part of a survey study of organics in Maxey Flats groundwater, we have developed a procedure for the isolation and characterization of trace levels of organics in radioactive groundwaters. Second, for a detailed chemical speciation study, a procedure based on steric exclusion chromatography was developed for determining whether or not organics are chelated on radionuclides.

Tran, T. V.

ADVANCED MEMBRANE FILTRATION PROCESS TREATS INDUSTRIAL WASTEWATER EFFICIENTLY
Chemical Engineering Progress, Vol. 1, No. 3, pp. 29-33, March 1985.

The combination of inert membrane material, large pore size, and tubular configuration makes the new membrane technology uniquely suited to the treatment of industrial wastewater. This process has consistently been effective and has proven results of arsenic removal to 0.05 mg/L and heavy-metal reduction typically to 0.1 mg/L or less. Membrane filtration systems, ranging in capacity from less than 2.3 m^3/h (10 gpm) to 45.5 m^3/h (200 gpm), are successfully treating wastewater for various industries, including printed circuit-board manufacturing, metal finishing, electronics, semiconductor, and industrial and domestic laundry. In addition, low-level radioactive wastewater from uranium mill tailing sites, laundries, and spent fuel storage ponds is being treated by the new membrane filtration process.

Treat, R. L.; Lokken, R. O.; Schliebe, M. J.

INCINERATION OF A TYPICAL LWR COMBUSTIBLE WASTE AND ANALYSIS OF THE RESULTING ASH
NUREG/CR-3087, PNL-4563, Pacific Northwest Laboratory, May 1983.

In this study, 4540 kg (10,000 lb) of simulated nuclear power plant combustible wastes was burned in a controlled-air incinerator. The purpose of this work was to generate ashes suitable for solidification, the products of which will be analyzed to determine if they are suitable for disposal. Two different types of waste were burned: (1) resins and simulated crud and (2) general trash (paper, plastics, wood, rubber, and cloth). Volume-reduction ratios (unburned waste: ash) were 13:1 and 22:1, respectively. Approximately 20% of the ash was lost due to adherence to incinerator walls and entrainment in the off-gas stream. Losses of the volatile species cesium and iodine were 79 and 100%, respectively. The ashes were not hygroscopic, but they exhibited a pH of 4.6 to 5.0 when water was added. Corrosion of mild steel drums would occur within this pH range. The ashes contained a significant quantity of clinkers having lengths as great as 20 cm (8 in.). Most of the clinkers were fully incinerated and easy to crush, suggesting that standard comminuting equipment should be effective in reducing the size of clinkers to allow their solidification with the fine ashes.

Trevorrow, L. E.; Gilbert, T. L.; Luner, C.; et al.

GREATER-CONFINEMENT DISPOSAL OF RADIOACTIVE WASTES
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 127-31, March 1985.

Low-level radioactive wastes include a broad spectrum of wastes that have different radionuclide concentrations, half-lives, and physical and chemical properties. Standard shallow-land burial practice can provide adequate protection of public health and safety for most low-level wastes, but a small volume fraction (1%) containing most of the activity inventory (90%) requires specific measures known as "greater-confinement disposal" (GCD). Different site characteristics and different waste characteristics -- such as high radionuclide concentrations, long radionuclide half-lives, high radionuclide mobility, and physical or chemical characteristics that present exceptional hazards -- lead to different GCD facility design requirements. Facility design alternatives considered, or GCD, include the augered shaft, deep trench, engineered structure, hydrofracture, improved waste form, and high-integrity container. Selection of an appropriate design must also consider the interplay between basic risk limits for protection of public health and safety, performance characteristics and objectives, costs, waste-acceptance criteria, waste characteristics, and site characteristics.

Trigilio, G.

VOLUME REDUCTION TECHNIQUES IN LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT
NUREG/CR-2206, Teknekron, Inc., September 1981.

This report presents a comprehensive compilation and data base of volume reduction techniques for low-level radioactive wastes generated in fuel-cycle and non-fuel-cycle facilities. Discussions of the volume reduction techniques are provided to include system descriptions, system performance data, volume reduction capabilities, process parameters, system limitations, and operating experience. An economic analysis is presented for shredding and compaction, incineration, calcination, evaporation/crystallization, and bituminization. PWR, BWR, and non-fuel-cycle waste scenarios are evaluated for volume-reduction techniques used at a waste generator's facility and on a regional basis. The economic analyses estimate costs of capital equipment, construction, operation, processing, transportation, and disposal at the Barnwell, South Carolina, and Hanford, Washington, disposal sites.

TRW Systems Group

ASSESSMENT OF INDUSTRIAL HAZARDOUS WASTE PRACTICES — ORGANIC CHEMICALS, PESTICIDES, AND EXPLOSIVES INDUSTRIES
PB-251-307, TRW Systems Group, April 1975.

This report is the result of a study of the "Assessment of Industrial Hazardous Waste Practices - Organic Chemicals, Pesticides, and Explosives Industries." This program is intended to provide the U.S. EPA with detailed and pertinent information on the generation, management, treatment, disposal, and costs related to wastes considered to be "potentially hazardous." Such information will be used in the development of their guidelines or standards for the management of hazardous wastes.

The objectives of this study were to determine, for the manufacturers of industrial organic chemicals, pesticide preparations and formulations, and explosives: (1) the quantities and geographic distributions of land-destined hazardous wastes, (2) present practices for treatment and disposal of land-destined hazardous wastes, (3) commercial control technology that could be applied to reduce the hazards presented by disposal of such wastes, and (4) the cost of present practices and the applicable commercial technology.

Turner, A. D.; Dell, R. M.

ELECTROCHEMISTRY AND RADIOACTIVE WASTES
Atom, No. 327, January 1984.

The prospect of using electrochemical methods as a step in treating radioactive wastes prior to disposal is investigated. Conventional dewatering processes (e.g., various forms of filtration) are not completely satisfactory for either the retention of colloidal matter achieved or the solids content of some resulting filter cakes. Ultrafiltration, using a microporous filter, yields acceptable decontamination of the permeate solution, but the filter soon becomes clogged and the separation process ceases, thus necessitating periodic backwashing. Electroosmosis offers the possibility of overcoming these problems. In this process, a weak-acid ion exchange resin is incorporated in a porous, conducting carbon electrode (e.g., carbon felt). When this electrode is made cathodic, a local alkaline environment is generated in its immediate vicinity. This leads to ionization of the weak-acid resin, followed by cation absorption from solution.

Turner, S. E.; Carson, W. E.; Mitchell, W., III

A STUDY OF RESEARCH NEEDS AND PRIORITIES IN RADIOACTIVE WASTE MANAGEMENT
Southern Science, Office of Black & Veatch, February 1984.

This report presents the results of an assessment of long-range research needs in nuclear waste management. The work reported was undertaken at the initiative of the Office of Program Analysis, Office of Energy Research, U.S. Department of Energy (DOE). In fiscal year 1983, the Office of Energy Research initiated this assessment as well as several others (in areas such as solar, thermal, photovoltaics, geothermal, and conservation); the purpose of the projects is to aid the Director of Energy Research in determining the health of DOEs research programs.

The intent of the project reported here was to identify additional basic research necessary in the 1980s and 1990s to develop an adequate scientific data base for nuclear waste management activities likely to be important around the turn of the century. The recommendations resulted from an overview of the entire area of nuclear waste management, not from focused examinations of narrow topics within that area. The suggested research may be the subject of future studies or more intense work by DOE.

Tucker, R. F., Jr.; Nelson, R. A.; Miller, C. C.

LOW-LEVEL RADWASTE SOLIDIFICATION
EPRI-NP-2900, Electric Power Research Institute, March 1983.

This report characterizes the radwaste solidification processes and systems currently in use and under development and identifies the types of waste, solidification agents, and general criteria that affect radwaste solidification systems and processes. The chemistry and physics of the radwaste solidification processes are discussed, along with a summary of several studies. The various radwaste solidification processes and corresponding commercial radwaste solidification systems are described. Radwaste shipping and burial containers, including high-integrity containers, along with container handling and storage systems are briefly discussed, and many of the commercially available containers are described. Other topics covered include dry active waste (DAW) production and DAW processing techniques; and some of the commercial processes are also provided.

Uematsu, K.

EXPERIENCES AND DEVELOPMENT STATUS ON FUEL REPROCESSING AND WASTE MANAGEMENT IN JAPAN
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 60-75, August 26-29, 1984.

The development plan of the nuclear fuel cycle is being revised because of a revision of the long-term energy supply and demand outlook in Japan. About 174 tons (174 Mg) of LWR spent fuel has been processed at the Tokai Reprocessing plant. Although leakage in two dissolvers in the plant was experienced during 1982-1983, these dissolvers were remotely repaired and a newly fabricated third dissolver is being installed. A commercial LWR fuel reprocessing plant is being planned. FBR fuel reprocessing technology development is progressing for the construction of an FBR Recycling Pilot Plant. The waste management program in Japan is based on the policy set forth by the Japanese Atomic Energy Committee and will be in construction in a few years. Feasibility studies, including activities relative to geologic disposal/repository, are under way.

US Ecology

US ECOLOGY, Promotional Brochure, circa 1984.

This brochure discusses a regional proposal for a two-chamber, controlled-air regional incinerator for low-level radioactive waste for North Carolina. The subjects that are discussed include:

1. how the incinerator works,
2. monitoring and emission control, and
3. a detailed description of the process.

US Ecology

US ECOLOGY, RICHLAND FACILITY, Promotional Brochure, December 1983.

A promotional brochure discusses the following topics:

1. Who is US Ecology, Inc.?
2. Why is the Richland site needed?
3. What types of waste are disposed of at Richland?
4. How is the waste buried?
5. Is the site secure?
6. How large is this facility?
7. What type of land is being utilized for waste disposal?
8. How is the site monitored?
9. Who regulates the Richland site?
10. How is long-term care and surveillance of the site assured?

The Richland facility facts are also detailed including location, geological synoposis, acreage, types of waste authorized, average trench, environmental monitoring, site security, taxation, etc.

US Ecology

US ECOLOGY, BEATTY FACILITY, Promotional Brochure, September 1983

A description of the facility at Beatty, Nevada, is given as well as how its functions are accomplished. The handling, disposal, monitoring, security, etc. are discussed relative to low-level radioactive waste (LLRW). Brief discussions of how waste is buried, who regulates the site, and surveillance are also included.

Uteka, N.; Fukasawa, T.; et al.

ALTERNATIVE SEALING MATERIALS FOR RADIOACTIVE WASTE - LONG-TERM STORAGE OR DISPOSAL
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 201-4, March 1985.

The properties of a Ca_3SiO_5-sodium silicate solution system were investigated for potential use in sealing radioactive waste. Preliminary experimental results showed that, after autoclaving, the solids had a high strength comparable to that of concrete, while their ability to immobilize radioactive nuclides was better than that of concrete. Additionally, these solids were expected to offer superior chemical stability during the long periods required for safe radioactive waste storage and disposal. Based on these results, the Ca_3SiO_5-sodium silicate solution system can be considered as a good alternative sealing material.

Van de Voorde, N.; Claes, J.; et al.

HIGH-TEMPERATURE INCINERATION - FINAL REPORT
EUR-7675-EN, Commission of the European Communities, 1982.

The system discussed in this report is an "integral" system, which directly transforms a definite mixture of burnable and unburnable radioactive waste to a final product with a sufficient insolubility for safe disposal. At the same time, a significant volume reduction is achieved.

The essential part of the system is a high-temperature incinerator. The construction of this oven started in 1974; and, while different tests with simulated inactive or very low-level active waste were carried out, the entire system was progressively and continuously extended and adapted, ending finally in an installation with completely remote control and enclosed in an alpha-tight room. In this report, a complete description of the plant and of its auxiliary installations will be given; then the already gained experimental results will be summarized. Finally, the planning for industrial operation will be briefly outlined.

An extended test with radioactive waste, which was carried out in March 1981, will be discussed in the appendix.

Van de Voorde, N.; Hennart, D.; Gijbels, J.; Mergan, L.

HIGH-TEMPERATURE SLAGGING INCINERATOR FOR TRU-WASTE TREATMENT
Fuel Reprocessing and Waste Management, Proceedings of the American Nuclear Society International Topical Meeting, Jackson, Wyoming, Vol. 1, pp. 538-48, August 26-29, 1984.

Since 1974, the Belgian Nuclear Study Center at Mol, with the support of the European Communities, has developed an "integral" system for the treatment and conditioning of radioactive contaminated wastes.

The system converts directly, at high temperature (1500°C), mixtures of combustibles (paper, plastics, rubber, etc.) and noncombustibles (i.e., metals, soil, sludge, concrete) contaminated with transuranium elements, as well as beta-gamma-emitting isotopes, into a chemically inert and physically stable slag. More than 4000 h of successful operation with a wide variety of simulated waste compositions, as well as real waste, have confirmed the safe operability of the high-temperature slagging incinerator and the connected installations, such as sorting cells, waste shredder, off-gas purification train, slag extraction system, remote control, and the alpha-containment building. During the fall of 1983, a final confirmation of the performance of the installation was given by the successful accomplishment of an incineration campaign of 16 to 17 tons (16 to 17 Mg) of simulated solid plutonium-contaminated wastes.

Van Kote, F.

TWELVE YEARS OF EXPERIENCE OF SHALLOW LAND DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE IN FRANCE
Symposium on Low-Level Waste Disposal, NUREG/CP-0028, CONF-820911, Vol. 3, pp. 177-200, September 1982.

In France, the long-term industrial management of radioactive waste is handled by a national agency, the Agence Nationale pour la Gestion des Dechets Radioactifs (ANDRA), which was created in 1979 within the French Atomic Energy Commission.

The French organization of radioactive waste management and ANDRA's work schedule and policy are briefly outlined. The solution adopted in France to dispose of low- and intermediate-activity-level, short-lived radioactive waste (LLRW and ILRW) is shallow-land burial at the Centre de la Manche, which was set in operation in 1969. The basic safety principles and technical options adopted for shallow land are reviewed, and the different steps of waste management at the Centre de la Manche are described. Finally, the major conclusions drawn from the 12 years of experience gained at the Centre de la Manche are detailed.

Van Swearingen, F. L.

INCINERATION OF MICROSPHERES
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. U1 to U5, March 1985.

One technique currently being used by researchers involves the injection of radio-labeled microspheres into animals. The animals are usually medium to large in size and have been injected with small microcurie amounts of radioisotopes. This makes them likely candidates for incineration. Our research indicates that the carcasses can be incinerated with other nonradioactive wastes, with good recoverability of the radioactivity.

Vaught, D. L.

PROJECT MANAGEMENT OF RADWASTE RETROFITS
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 417-22, March 1985.

Many utilities are finding it necessary to provide additional radioactive waste processing facilities at operating or nearly completed nuclear stations in order to accommodate the ever-changing regulatory, political, and socioeconomic environment in which we operate. This paper describes the project approach taken at Duke Power Company to provide a comprehensive radioactive waste processing facility at Oconee Nuclear Station. Following a historical perspective, which includes a brief description of the facility scope, the philosophy and mechanics of the project team are discussed. The goal of the project team was to provide a facility that could meet the liquid and solid radioactive waste processing needs of Oconee within the restraints of a utility budget and schedule. The unique quality of the project team approach was the integral involvement of all the necessary departments in every part of the design, construction, and start-up phases. The project team thereby utilized feedback from over 30 years of reactor operational experience. It is the lack of feedback from the ever-changing operation/regulatory arena that often renders new radwaste systems obsolete prior to operation.

Vavruska, J. S.; Stretz, L. A.; Borduin, L. C.

HAZARDOUS AND RADIOACTIVE-WASTE-INCINERATION STUDIES AT LOS ALAMOS
LA-UR-81-1170, Los Alamos Scientific Laboratory, May 1981.

Development and demonstration of a transuranic (TRU) waste volume-reduction process are described. A production-scale controlled-air incinerator using commercially available equipment and technology has been modified for solid radioactive waste service. This unit successfully demonstrated the volume reduction of TRU waste with an average TRU content of about 20 nCi/g. The same incinerator and off-gas treatment system is being modified further to evaluate the destruction of hazardous liquid wastes such as polychlorinated biphenyls and hazardous solid wastes such as pentachlorophenol-treated wood.

Walker, J. F., Jr.; Brown, C. H., Jr.; Dinsmore, G. B.

EVALUATION OF THE PROPOSED Y-12 STEAM PLANT WASTEWATER TREATMENT SYSTEM
ORNL/TM-9234, Oak Ridge National Laboratory, September 1984.

A wastewater treatment facility has been conceptually designed to treat the Y-12 steam plant and ancillary effluents to meet the Clean Water Act's "Best Available Technology" limitations. This report presents the results of a program to acquire representative samples of the major effluents to be treated in this facility, to characterize these samples, and to perform a bench-scale evaluation of the conceptual design flowsheet.

Results indicate that the wastewater can be successfully treated with $Ca(OH)_2$ to remove all pollutants, except copper, silver, and TSS, to levels specified in the "Probable Limits for Y-12 Process Waste Discharges to East Fork Poplar Creek." Flocculation of the sludge produced by the $Ca(OH)_2$ coagulation with Purifloc A23 reduces sludge volume by 69%. Results also indicate that vacuum filtration is a better alternative than centrifugation for dewatering the sludge.

Waller, M. J.; Singh, R.; Bloom, J. A.

RETROFIT OF THE EPA ENVIRONMENTAL EMERGENCY RESPONSE UNIT'S IN-SITU CONTAINMENT/TREATMENT SYSTEM FOR TOXIC SPILL AND . . .
Earth Tech, Environmental Protection Agency, January 1983.

A state-of-the-art review of chemical injection methods, in-situ soil washing techniques, and containment procedures for toxic waste cleanup at spills and waste impoundment sites is reported. This review was used for the redesign of the Environmental Protection Agency's Environmental Emergency Response Unit's mobile In-situ Containment Treatment Unit (ISCTU). It provided guidelines for determining ISCTU system capabilities and design constraints. The report is divided into two major topic areas: (1) chemical countermeasures and (2) grouting and containment procedures. Under chemical countermeasures, soil treatment techniques, such as flushing, washing, oxidation, reduction or neutralization, and biological degradation, are discussed. Grouting discussions include grout properties, grouting techniques, and quality control/quality assurance issues. The report contains an annotated bibliography of 35 reports relevant to the subject area.

Walter, M. B.; Graham, M. J.; Gee, G. W.

A FIELD LYSIMETER FACILITY FOR EVALUATING THE PERFORMANCE OF COMMERCIAL SOLIDIFIED LOW-LEVEL WASTE
PNL-5253, Pacific Northwest Laboratory, November 1984.

A field lysimeter facility established at the Hanford site, near Richland, Washington, is being used to determine typical source terms in arid climates for commercial low-level wastes solidified with cement, Dow polymer (vinyl ester—styrene), and bitumen.

The purpose of this document is to describe this field lysimeter as part of DOE's low-level waste management research efforts. In addition to the field monitoring, which is the central purpose of the program, a series of laboratory testing and geochemical modeling exercises is being conducted. The goal of the laboratory and modeling work is to determine which mechanisms are controlling the release of radioactivity from the forms.

Wamsley, B. (Editor)

COMMERCIAL NUCLEAR POWER PLANTS
NUS Corporation, Edition No. 17, February 1985.

This publication provides statistics on commercial nuclear power plants operating, or under construction, in the United States today. It also tells which plants are now going into commercial operation.

The publication includes a summary section, which provides a brief overview of the nuclear utility industry nationwide and how it fared during 1984.

Warren, B. C.

QUALITY ASSURANCE IN CENTRAL PROCESSING FACILITIES
Incineration of Low-Level Radioactive Wastes: 1985, Lecture Notes, Tucson, Arizona, pp. V1 to V4, March 1985.

Over the past several years, the disposal of radioactive wastes has been in the news regularly. The result has been that the governors of the existing burial host states have reiterated that their states are not going to be the perpetual dumping site for the United States. The country must find alternatives. Thus, the regional Compact concept evolved; alternative methods for disposal have been researched and developed; and, through the changes in the 10 CFR Part 61 and 10 CFR 20.311, an apparently tighter control on the quality of materials being buried has been instituted.

This paper evaluates how far we have come, as it pertains to the quality of our efforts; and where we are going.

Warren, J. H.

DESIGN OF AN EXPERIMENTAL INCINERATOR FOR ALPHA WASTE
DP-1521, E. I. du Pont de Nemours and Company, August 1979.

An electrically heated, controlled-air, two-stage incinerator has been designed at the Savannah River Laboratory for burning small volumes (5 kg/h) of solid wastes. Distinguishing features of the design are compactness, relatively light weight, and ease of assembly made possible by using prefabricated ceramic components to form two combustion chambers surrounded by packed-fiber insulation within a steel case. Electric girdle heaters around the two combustion chambers provide 600 to 1000°C. These temperatures, combined with controlled air, give minimum ash entrainment and long combustion gas residence times to yield 10^9 off-gas decontamination factors with conventional off-gas cleaning equipment. After decommissioning, the design allows for ease of disassembly and convenient disposal of the ceramic components.

Washington State Department of Social and Health Services

FACT BOOK: DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE IN WASHINGTON STATE
Washington State Department of Social and Health Services, 1983.

The State of Washington, Department of Social and Health Services, Radiation Control Section, is responsible for the surveillance of low-level radioactive waste disposal operations performed by U.S. Ecology, Inc., on the Hanford Nuclear Reservation. U.S. Ecology, Inc., of Louisville, Kentucky, is licensed by the State of Washington to operate the radioactive waste disposal site on 100 acres of land leased from the State of Washington. This fact book is intended to provide previously hard-to-obtain information on low-level radioactive waste to parties interested in low-level waste disposal in Washington, in the other states of the Northwest Regional Compact, and in other regions considering the establishment of such disposal sites. The book deals strictly with low-level disposal and can be used to give answers to such questions as: How much waste comes into Washington? From where? What is Washington doing to regulate low-level waste? How does Washington compare with the other two states with commercial low-level waste disposal sites? This report draws no conclusions. Rather, it presents factual information that the reader can use to draw his/her own conclusions regarding low-level waste in Washington.

Waters, R. M.; Moscardini, R. L.

DESIGN CONSIDERATIONS FOR LOW-LEVEL RADIOACTIVE WASTE COMBUSTORS
Waste Management '82, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 497-505, March 1982.

Combustion Engineering's Waste Incineration System (C-E/WIS) uses suspension burning in an excess air atmosphere for maximum volume reduction and safety. Pyrolysis and starved-air combustion, when applied to the incineration of radioactive waste materials, must be considered with caution. All waste, from liquids through resin slurries to dry active wastes, cannot be handled effectively with these processes. The use of these designs results in less than maximum volume reductions and increases the potential for unsafe operation. The design of C-E/WIS's combustor is unique in that it has been specifically designed to accommodate all the waste incineration requirements of an operating nuclear power plant. Full-scale prototype tests of the C-E/WIS have demonstrated its capability to incinerate wastes safely with the maximum reduction in volume.

Waters, R. M.; Volodzko, M.

THE IMPACT OF PVC ON WASTE INCINERATION SYSTEMS
Paper presented at American Nuclear Society Conference, Combustion Engineering, Inc., August 1983.

Governed by increasing burial costs and other adverse economic factors, more and more emphasis is being placed on finding methods to reduce volumes of power reactor wastes. Incineration is one such method.

Incinerable mixes of dry active waste can contain various quantities of polyvinyl chlorides (PVCs). These PVCs have an adverse impact on incineration processes in terms of (1) potential chloride attack on process materials and (2) reduced volume reduction factors resulting from chemical addition required for chloride neutralization. The end result is an overall system cost increase due to selections of sophisticated materials and an overall cost increase for packaging, transporting, and burying the incinerator ash product.

This paper presents Combustion Engineering, Inc.'s (C-E's) selection criteria for materials in the C-E Waste Incineration System. A critique of the impact on system volume reduction factors for a range of PVC in the waste stream is also included.

Wickham, L. E.

CALCULATING THE CHEMICAL HAZARD OF RADIOACTIVE WASTE
ECG-M--19683, EG&G Idaho, Inc., 1984.

Low-level radioactive wastes contain a wide variety of substances that are both radioactive and chemically hazardous. While the radioactive characteristics of these wastes have been defined, chemical components have been ignored from a management and regulatory point of view. In this paper, a methodology for quantitatively comparing the hazards of various chemicals with those of radioactive materials is presented in the form of a waste classification system. This system considers the hazards of materials based on intrinsic toxicity, persistence through time, availability to a human receptor, and buildup of decay or degradation products. The system has been applied to a number of materials to show its versatility. Examples are provided.

Wilke, M.; Fatho, K.

INCINERATION OF RADIOACTIVE WASTES APPLYING THE "JUELICH INCINERATION PROCESS"
Kaftanlagen Aktiengesellschaft, Heidelberg, April 1981.

Development of the Juelich incineration process started in 1969. Its purpose was to burn waste from the Juelich nuclear research plant in Germany. Today, comprehensive operating experience of several years is available, and a large number of test runs have been made on the prototype plant. The data collected permit the design of future incineration plants of different capacities and for most different waste compositions. Incineration by the Juelich process is made in two stages. In the first stage, the waste is thermally treated by pyrolysis. Only in the second stage are these pyrolysis products burned. Both energy and waste flows are routed through the incineration plant in a parallel direction. The temperatures in the treatment chamber range between 100 and 800°C. Since the maximum temperatures reached during pyrolysis are about 800°C, this process stage is to be considered as medium-temperature pyrolysis. In the thermal treatment chamber, the waste is initially dried at rising temperatures and then degassed and/or gasified and coked. The pyrolysis products are then completely burned in the combustion chamber at about 900°C using a controlled air supply.

Williams, D. L.; Deacon, L. E.

NEUTRALIZATION METHOD FOR A HYDROFLUORIC ACID RELEASE
GAT-837, Goodyear Atomic Corporation, October 1976.

A laboratory investigation of methods for neutralizing a release at the hydrofluoric acid tank farm at the Portsmouth Gaseous Diffusion Plant has revealed that the best neutralization method incorporates the use of a lime-water slurry. In this method, settling of suspended solids in the liquid is enhanced by the application of sodium dodecyl sulfate, which causes immediate flocculation and settling. Dilution and expulsion of the supernatant liquid above the flocculated solids result in an effluent that meets the 1-ppm fluoride limit established by the U.S. Environmental Protection Agency. A fluoride-specific ion electrode is used to determine fluoride concentration. This method is being adapted for use in the hydrofluoric acid tank farm and is being considered for use at the plant's fluorine generation facility. It could be adapted for use in any facility that contains fluoride in aqueous solution.

Yezzi, J. J., Jr.; Brugger, J. E.; Wilder, E.; Freestone, F.; et al.

EPA'S MOBILE INCINERATION SYSTEM FOR CLEANUP OF HAZARDOUS SUBSTANCE SPILLS AND WASTE SITES
EPA/600/14, IT Corporation, 1984.

This report contains three papers that discuss the trial burn of the EPA's Mobile Incineration System for the purpose of destroying hazardous materials on-site. The test program consisted of a series of five tests that were designed to evaluate the system's ability to destroy selected hazardous organic materials and to control emissions of HCl, particulate matter, and organics in accordance with the requirements of the TSCA, RCRA, and the New Jersey State Department of Environmental Protection. Discussed herein are (1) the trial burn plan, including the sampling and analytical program; (2) the results of the tests; and (3) the impact of the test program on the local environment. The function of the Mobile Incineration System is to demonstrate the ability of on-site thermal destruction of hazardous materials at remote spill or disposal sites. Because treatment of hazardous materials is controlled by state and federal regulations, a trial burn plan was developed to comply with these regulations and to establish the performance capability of the system in destroying/detoxifying hazardous and toxic substances.

Young, R. A.

PROCEEDINGS OF THE SECOND ANNUAL HAZARDOUS MATERIALS MANAGEMENT CONFERENCE
Proceedings of the Hazardous Materials Management Conference and Exhibition in Philadelphia, Pennsylvania, June 1984.

Seventy-three different papers are presented pertaining to 30 subjects. These proceedings were held as part of the Hazardous Materials Management Conference and Exhibition in Philadelphia, Pennsylvania, June 5-7, 1984.

Not all the papers presented at the conference were available for publication.

Zigelman, D. A.; Mis, F. J.

VOLUME REDUCTION OF DRY ACTIVE WASTE - THE MOBILE SERVICE OPTION
Waste Management '85, Proceedings of the Symposium on Waste Management at Tucson, Arizona, R. G. Post, ed., Vol. 2, pp. 517-22, March 1985.

Dry activated waste (DAW) produced at nuclear power plants accounts for the largest fraction of the radioactive waste volume generated and shipped for burial. Since burial of this waste is charged on a dollar-per-cubic-foot basis, the application of advanced volume-reduction techniques to DAW merits attention to reduce a plant's burial costs. This paper addresses the mobile high-force-compaction service option as an economic alternative to capital expenditures for purchase of volume-reduction equipment.

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